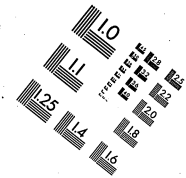

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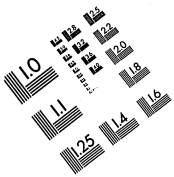

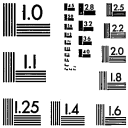

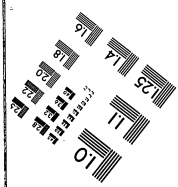

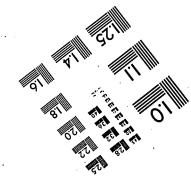

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A SELECTIVE MICROFILM EDITION

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(1879–1886)

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THOMAS A. EDISON PAPERS

A SELECTIVE MICROFILM EDITION
PART II
(1879-1886)

REEL 92

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Charles Batchelor Collection
Patents
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CHARLES BATCHELOR PATENTS, 1869-1880

Included in this series is one volume of Edison's British patents from the years 1872-1880 (Cat. 1321) and one volume of Edison's U.S. patents from the years 1869-1879 (Cat. 1320). Only the British patents have been filmed. The Batchelor Collection also contains numerous unbound patents issued to Edison, Batchelor, and other inventors. A complete set of Edison's U.S. patents can be found in Thomas A. Edison Papers Microfilm Edison, Part I, reels 1-2.

Edison's British Patents, Cat. 1321

This book covers the years 1872-1880 and contains printed copies of British patents issued to Edison. The patents relate to several inventions, including printing, automatic, and multiplex telegraphs; the electric pen and autographic press; the telephone; electric lighting; and polyform. All of the patents are complete as issued by the British Patent Office. Many are accompanied by drawings. A few of the patents appear in the form of provisional specifications. A provisional specification in the British patent system was similar to the caveat in the U.S. patent system. It protected the inventor for a period of time prior to the filing of a full specification. The description of the invention and the statement of claims were generally less detailed in a provisional specification than in a full specification. The spine of the book is stamped "Edison's British Patents 1872-1880."

A.D. 1872, 13th May. N° 1453.

Printing Telegraphs.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN PRINTING TELEGRAPHS."

Sealed the 24th September 1872, and dated the 13th May 1872.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents, with his Petition, on the 13th May 1872.

I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN PRINTING TELEGRAPHS," to be as follows:—

These improvements relate to the mechanism for moving the several type wheels of different printing telegraphs in unison, and giving the impression.

The type wheel is mounted upon a shaft, and revolved by a step-by-step motion by a lever and armature acted upon by an electro-magnet, the core of which is grooved upon one side longitudinally, which I find

is preferable in printing telegraphs, because greater speed can be obtained.

Where two line wires are used, one to the type-wheel magnet, the other to the printing magnet, the ratchet wheel of the step-by-step movement has half as many teeth as there are types and spaces on the type wheel, and one letter is printed on the open circuit and the next on the closed circuit, and this type wheel is on a sleeve and moved by a lever acted on by the printing lever. The type wheel can be turned around the extent of one letter, so as to print the alternate letters that had previously been out of position for printing. This same turning movement of the type wheel on its shaft is sometimes communicated by a V shaped wedge and holding dog, acted upon by the printing lever.

The type wheels are stopped at unison by the continued rotation of the type wheel bringing an arm into the path of a stop on the type-wheel shaft, and this is liberated by operating the printing lever.

In cases where the unison can be operated most conveniently by the printing lever, it is effected by a wedge thereon acting against inclined teeth on a wheel upon the type-wheel shaft. The absence of one tooth in this wheel prevents the further action of the wedge at the unison point.

The printing lever is provided with a weight that prevents it being easily moved by the electro-magnet, but when moved its inertia effects the impression. This can be used on one line wire instruments, the impression being given after the type wheel is set by keeping the circuit closed. An air cylinder with a piston also is employed to prevent the printing lever moving, except by keeping the circuit closed a sufficient time.

The paper is drawn along by a swinging claw or tooth pressed upon the paper by a toggle or spring, and then moving with a swinging segment or a roller, and a holding pawl keeps the paper from drawing back.

Where two type wheels are used, and an end movement is given upon the shaft to bring one into action and remove the other from action, the said end movement is given either by an electro-magnet and polarized armature that will be held in contact with the cores or repelled according to the polarity of the current, or the printing may be from one type

wheel with an open circuit and from the other with a closed circuit, or else the endwise movement is given from the printing lever by lever or wedge acting connections operating upon radially slotted wheels.

It is to be understood that the printing instruments before described are located at the places or stations distant from the sending or transmitting station, and that they are operated by electric pulsations given from the said transmitting station. I now describe the pulsator to be used at said transmitting station to send these electric pulsations:—A motor made of a shaft and armature revolved by stationary electro-magnets gives motion by a friction clutch to a circuit breaker made of alternate conducting and non-conducting material. The type wheel at the distant station is moved around by these pulsations in unison with a revolving arm at the transmitter (actuated by gearing from the pulsator), and when this arm is stopped by depressing one of a range of finger keys the pulsator is stopped, also the type wheel, and the printing circuit brought into action. The speed of the pulsator shaft is regulated by a governor, that acts as a circuit breaker to the electro-magnets of the motor, or "cuts out" those magnets by closing a shunt or more direct circuit.

Where many printing telegraphs are worked in several circuits by one transmitter or pulsator, it is often preferable to employ short relay magnets with slotted cores and relay circuits between the transmitting and printing instruments.

SPECIFICATION filed in pursuance of the conditions of the Letters Patent, and of an Order of the Lord Chancellor, by the said Thomas Alva Edison in the Great Seal Patent Office on the 15th November 1872.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Thirteenth day of May, in the year of our Lord One thousand eight hundred and seventy-two, in the thirty-fifth year of Her reign, did, for Herself, Her heirs and successors, give

and grant unto me, the said Thomas Alva Edison, Her special licence that I, the said Thomas Alva Edison, my executors, administrators, and assigns, or such others as I, the said Thomas Alva Edison, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN PRINTING TELEGRAPHS," upon the condition (amongst others) that I, the said Thomas Alva Edison, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Thomas Alva Edison, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being made to the Drawings hereunto annexed, and to the letters and figures marked thereon (that is to say):—

My improvements comprise a system of reporting from one central point to any number of distant points the quotations of market values, gold, stocks, and other articles of trade or merchandize.

The first part of this improvement relates to a machine that is termed a "transmitter," in which there are finger keys or stops that are allotted to the respective characters employed. There is also in this instrument a "pulsator" that makes and breaks an electric circuit passing through a range of relay magnets, and opens and closes these until the pulsator is stopped by the depression of one of the finger keys.

The second part of my Invention relates to the arrangement of the respective electric circuits that connect this transmitter with the relay magnets and the circuits that are operated by those relay magnets, and pass through the printing telegraph instruments, a number of these instruments being placed in each circuit, so that one transmitting instrument will operate in unison any number of printing telegraph

instruments, to the extent of hundreds, and in case of defect in any one local circuit the other circuits will not be disarranged.

The third part of this Invention relates to the printing telegraph instruments themselves, with the modifications in construction adapted to various uses, and the appliances that are employed in or with such instruments for effecting the various operations or for preventing difficulties that may arise under different circumstances.

In the Drawings, Fig. 1 is a plan of the transmitter, and a diagram is also shown representing the circuits to the relay magnets and printing instruments, in which two wires are employed, one wire and circuit to the type wheel magnets, the other to the printing magnets; in Fig. 2 a diagram is shown of the transmitter and circuits to printing telegraph instruments operated by one wire and electric circuit; and Fig. 3 represents the transmitting instrument by a vertical section.

The shaft a of the transmitting instrument is preferably revolved by magnetism. For this purpose two stationary magnets are used, one of which a^1 is seen in Fig. 3, and there are three armatures 2, 2, 2; and upon the shaft a is a circuit breaker 3 of alternate conducting and non-conducting material that opens and closes the circuit to the magnets a^1 alternately, so as to attract the armatures successively and revolve the shaft a. The battery a^2 operates this motor, the wires being connected at 4 to the bed b of the machine, and at 5 to the insulated binder, and from that to the magnets a^1 and to the lever and roller 6 of the respective pulsators, thence through the shaft a and bed b to 4. Upon the shaft a are governor balls b^1 that rise by increased speed and bring the flange 7 of the sliding sleeve into contact with the adjustable insulated arm 18, Fig. 3, and the friction will check the speed, but it is preferable to connect therewith a wire 95, so that the electricity will be "short circuited," passing through 4, b, a, 7, 18, and 95 to 5 instead of going through the electro-magnets a^1, thus lessening the power and the speed and maintaining uniformity in the revolution of the motor.

If the governor balls act to connect a circuit through the magnets a^1, a^1, the slight electro-magnetism remaining in the cores of the motor magnets will act to detain the armature in revolving, and thereby lessen the speed; and if the pin is below the flange 7, and the circuit to the motor magnets passes that way, then the power will be checked when the

maximum speed is attained by opening the circuit to said motor magnets.

By a suitable connection such as the gearing 8, 9, 10, the shaft c is revolved with the desired speed. It has two arms c^1, c^2, on opposite sides, one above the other, and these act in connection with two semi-circular ranges of finger keys d, d^1. Beneath the bed b these finger keys have arms d^2, d^3, converging towards the center of c, and when one of the keys d^1 is depressed its arm d^3 stops the arm c^2, shaft c, and gears 8, 9, 10. The gear 8 is driven by friction, hence the motor and shaft a continue to revolve, but connected with the gear 8 is a pulsator e made of alternate conducting and non-conducting surfaces, and these open and close the circuits to the distant printing instruments or to the relay magnets.

By bearing in mind that the parts are made so that the pulsator e transmits the necessary number of pulsations to make a complete revolution of the type wheels (at the distant instruments by a step-by-step movement), each complete revolution of the shaft c, it will be understood that the shaft c and the type wheels revolve in harmony, and that when the shaft c is stopped by one of the keys d, or d^1, the type wheels of the distant instruments are stopped, and the position of the characters on the type wheels must be in harmony with the arrangement of the keys d, d^1, and when the key is liberated, the shaft c and pulsator e resume their revolution and the distant type wheels also resume the synchronous movement.

The printing telegraph machines illustrated at A, A, are operated by two wires, those shown at B, B, Fig. 2, are operated by one wire; hence with two wire instruments two ranges of relay magnets e^1, e^1, and e^2, e^2, will be required, while only the range e^1 of relay magnets will be needed with one wire instruments.

When two ranges of relay magnets are used, there are two rollers or contact springs 12 and 13, on insulated spring levers; one is connected to the binding screw 14, the other to the binder 15, and the parts are positioned so that the pulsator e, as it revolves, opens and closes the circuit from the battery e^4, through the relay magnets e^1, to make and break the circuit at 16 from the batteries e^3, through the type-wheel electro-magnets in the distant instruments A.

The relay magnets e^2 will not respond, although the circuit is closed by the roller 13, because the springs of the armatures of the electro-magnets e^2 are under considerable tension, and the pulsator contact points are small and send but a very short impulse, but when the pulsator e is stopped by depressing one of the keys, the roller 12 rests upon a non-conducting surface breaking the circuit through e^1, and the roller 13 resting on a conductor closes the circuit through the relays e^2, causing them to close the circuits at 17 of the batteries e^3, hence they act in the distant instruments A in the electro-magnets that effect the printing. The pulsator e when employed with the single range of relay magnets e^1, as in Fig. 2, causes the pulsations to be repeated at 16 from the batteries e^4 to the distant instrument, and when the printing is effected by a pause on a closed circuit the pulsator e is stopped with the roller 12 in contact with the metallic portion of the pulsator, but if the printing is effected by a pause upon an open circuit the roller 12 is in contact with a non-conducting portion of the pulsator e.

I have shown the battery e^3 in three sections connected with the respective relay magnets and with three circuits, in each of which circuits there may be any desired number of printing telegraph instruments, and the circuits are completed through the ground connections.

The circuits to the transmitting instrument and the relay magnets may be disconnected by a switch at e^5 that may be turned around to throw both batteries out of action, and the circuits from the batteries e^3 will also be broken at the relay magnets.

It is preferable to employ slotted cores in the relay magnets and to make these cores short, say not over two centimetres in length, and it is preferable to employ a detached layer of wire around the outside of each electro-magnet helix, which in practice will be found to lessen the sparks at and the burning of the contact points without decreasing the power of the electro-magnet. This extra layer or layers of wire should be put upon the outside of each magnet in the printing instruments to lessen the spark due to the discharge of the induced magnetism from the iron cores.

The printing telegraph instruments and the appliances connected with them form the third part of this Invention.

Figs. 5, 6, & 7 are vertical sections of the printing instruments; Figs. 8 and 9 are elevations endwise of the printing lever; and Fig. 10

is a plan of the instrument. The base f of the instrument is of metal with frames f^1 that support the type wheel shaft g, upon which is the type wheel or wheels (l, l^1,) and the electro-magnet h is employed to move a lever h^1, and by a step-by-step movement from pawls or wedge-acting teeth i operating upon a toothed wheel k the type wheel will be moved around progressively by the electrical pulsations aforesaid acting in the magnet h.

The electro-magnet m actuates the printing lever m^1 to give the impression, and this electro-magnet m is energized when the type wheel has been turned, and the proper letter or character brought into position for printing.

The arms 20 extend up sufficiently to carry a reel with the strip of paper, and the types on the wheel are inked by a roller 21. A spring 22, Figs. 5 & 8, may be used to press the ink roller upon the types.

Wherever the before described parts are shown in the various figures the same letters of reference are applied.

The magnets m and h are adjustable vertically by screws 23, 24, that pass through the bed f and act upon the cross bars carrying the magnets, and the soft iron cores of the electro-magnets are by preference made with a longitudinal slot, as seen in Fig. 4, so that the residual magnetism will be freely discharged, and the helix are preferable when made of fine wire without insulating covering wound by machinery, and with a layer of paper between one layer of wire and the next. The line wires of the electric circuits are connected with the binding screws 26 for the magnet h, and with the binders 27 for the magnet m.

The improvements in the printing instrument divide themselves into the following features:—

First. Means for printing from one of two type wheels while the other type wheel is not being printed from.

Second. Means for bringing all the type wheels in the various printing instruments into unison by turning them around to a unison or stopping point and then liberating them all at once, so that all start together, and thus errors in printing are avoided.

Third. Means for moving the strip of paper along. The type wheels l l^1, Figs 7, 9, and 10, are upon a sleeve o that slides endwise of the

shaft g; to this is connected a T lever o^1, and upon the printing lever m^1 are two stops or pins 30 & 31, positioned so that when the type wheels are stopped at one point and the printing lever is moved, the pin 30 taking one end of the lever o^1 will shift the type wheels in one direction, and if turned around another notch (of k), the other pin will act on o^1, as the printing lever is moved, and shift the type wheels the other way. Upon the printing lever m^1 is a shield o^2 of thin metal under which the strip of paper passes and in which shield is in an opening so that one type wheel will print through the opening, the other being kept from touching the paper; there is a printing pad p^6 on the printing lever below the paper at this point.

The person at the transmitting station brings either type wheel into action by stopping all the type wheels at the proper position and allowing the printing lever to be moved by closing the circuit through the printing magnet. As there are but two points where the change can be made either one way or the other, a disk p is used on the type wheel sleeve or shaft with a notch, and the cam p^1 is on either one side or the other of the disk, so that the parts cannot shake out of place.

The type wheels may be shifted endwise by a magnet q and lever q^1, see Fig 11, acting on the sliding sleeve o. In this case the electric circuit passes through the magnet h, then through the magnet q and the toothed wheel k, on the type wheel shaft, g is to be of the character shown in Fig 7, so that the rotation of g will be half a space (of k), as the lever h^1 is attracted by h, and the other half space as the lever h^1 is drawn back by its spring. If therefore the circuit is kept closed through h and g, the type wheel l will be held in position to be printed from, but if the printing circuit through m is closed when the electric circuit through h, q, is broken, then the wheel l^1 will be in position for being printed from, the spring q^2 moving the type wheels to the left, Fig 11. The types on l, l^1, in this instance must be positioned so that the type on one wheel is in line with the space between two types on the other wheel.

If the armature q^3 of the magnet q is permanently magnetized, then it will either be attracted or repelled, according to the polarity of the electric current passing through q, therefore by this modification one type wheel will be brought to position for printing by a positive current and the other by a negative current. The same is the case with the

types on the wheels shown in Figs. 12, 14, but in these Figures the shifting is accomplished mechanically instead of electrically by levers or inclines r, r^1, moved by the printing lever m^1, and acting against the notched wheels r^2 r^3. These parts are positioned so that with a closed electric circuit the lever or incline r will press against the side of the wheel r^2 and shift the type wheels to the left to print from the wheel l^1, and the lever or incline r^1 will not be operative because it will pass into the notch in r^3, as shown in Figs 13 & 15, but when the printing lever m^1 is moved with the electric circuit through h open, the lever or incline r^1 will operate on r^3, and shift the type wheels the other way, and bring the type wheel l into position for printing from.

Where the characters on the type wheels are positioned in two rows as in Fig 16, with the characters in one row opposite the spaces in the other row, it is necessary that the type wheel should be turned around upon its axis a distance equal to half a space to bring one row of characters in position for being printed from, and the other row where there will not be any impression on account of the spaces between the types coming over the impression pad. I accomplish this by a T headed spring bolt s that enters one of two notches on an arm 35, that extends from the sleeve of the type wheel. When this bolt s is raised as in Fig 18 by the impression lever m^1 the type wheel and arm 35 can be turned by a wedge tooth s^2 on the lever m^1, acting against one of the inclined faces of the arm 36. If the type wheel is to be moved the other way half a space the type wheel is rotated further around so that the wedge tooth s^2 acts the other way on the opposite face of the incline 36.

When the printing lever recedes, as in Fig. 17, the T head of the bolt s holds the type wheel in place by falling into the appropriate notch in 35. A similar movement is given to the type wheel by the device shown in Fig. 8, wherein the lever o^1 shifts the cam 36 and turns the type wheel partially around upon its axis; in this case the movement may either be an entire letter space so as to print from alternate letters or characters, one set of characters being in position for impression when shifted one way, and the intermediate letters or characters being in position for printing when shifted the other way.

Figs. 19 and 20 are plan views of the machines in which the two type wheels are employed as before; but instead of moving the type wheels, the printing levers are made in two parts, with separate impression pads, as seen in Fig. 21, and notched wheels r^2, r^3, are attached upon the shaft g instead of the sleeves o, as in Figs. 12 & 14, and although both the printing magnets m, m^4, are energized only one printing lever m^1 can move because the finger r^1 rises in the notch of the wheel r^3, see Figs 19, 21, and 22, and the other lever m^{14} is stopped from rising because its finger r comes in contact with the projection or tooth of the notched wheel r^2, thus one type wheel l will be printed from on the open circuit (through h), and the other wheel l^1 will be printed from when the circuit through h is closed.

In Fig. 20 the separate impression pads and levers are controled electrically instead of mechanically. In this case the arm 45 on the axis of the type wheel lever closes the circuit, as seen in Fig. 23, to the magnet m when the magnet h is energized, and on the open circuit of the magnet h, the said arm 45 will close the circuit through the magnet m^4, and thereby an impression will be taken when the type wheels stop rotating from either the wheel l or l^1, according to whether the wheels are stopped on an open or a closed circuit through h.

It is to be understood that the pulsations in h and the vibrations of 45 are too rapid to allow either magnet m or m^4 to be energized until a pause takes place and the type wheels stop.

In instruments where there is but one wire passing through both the printing magnet m and the type wheel magnet h, as seen in the small inverted plan, 24, there will be a movement of the printing lever each pulsation that is sent for setting the type wheel if there is not a resistance to the movement of the printing lever that checks that movement during the ordinary pulsations; but that resistance is overcome during a pause sufficient for developing the full power of the printing magnet. This resistance to the movement of the printing lever may be a spring, but the weight m^8, Figs. 7, 9, and 24, is preferable, as it prevents by its inertia a sudden movement, and when in motion the inertia aids the power of the electro-magnet in striking the pad against the paper with a sufficient blow to make a good impression.

In Fig. 25 this resistance to the movement of the printing lever is obtained by employing an air cylinder and piston, the latter being connected to the lever m^1 by a rod m^{12}. In this case the pulsations in the magnet h operate to set the type wheel l or l^1 by a step-by-step movement; but they do not move the impression lever m^1 sufficiently for

printing because the spring m^{13} is acting upon the same, and the air cushion in the cylinder formed between the piston and the cylinder arrests any sudden movement, and the spring m^{13} acts between the pulsations to keep the piston from gradually forcing the air out of the cylinder; but when the circuit is kept closed at the transmitting station the printing lever is allowed to move and give the impression, as the rod m^{12} moves the piston and displaces the air cushion sufficiently to allow of this movement. The piston may have a valve to open as the lever descends so as to allow the printing pad to move rapidly away from the type wheel.

The next feature of this Invention relates to an automatic device for bringing all the type wheels to a unison or harmonious starting point. Ordinarily it is not necessary to rotate the type wheels more than two revolutions before the required letter will be in position for printing. The unison is brought into action by giving to the type wheels two or more revolutions, and in the act of so doing bringing into action a stop that arrests the further movement of the type wheel, but the pulsations are continued sufficiently to bring up to that stop any type wheels that may be out of unison, and then upon operating the printing lever a movement is given to the unison stop that liberates the type wheels all at once, and they are then in position for starting again in unison. The most convenient unison is an arm o^4 with the end in a screw thread o^5 on the shaft g, and a pin 50 that stops against the end of that arm, and when the printing lever m^1 is moved the arm o is lifted out of the screw o^5 by the forked bar 53, and a spring 51, Figs. 9 & 10, returns it to a normal position. The pin 50 may be in the side of a disk, and a volute groove in the disk take the place of a screw.

In Figs 5 & 8 an arm o^7 is shown on the type wheel shaft g, taking in succession the teeth 54 on the arm o^4, and drawing it down into the path of 50, the stop o^4 is lifted by the bar 53, as before, when the printing lever is moved.

In instances where the type wheel is moved half a space on closing the circuit and the printing takes place on an open circuit, a unison wheel can be employed, such as shown in Figs. 6 and 26. In this instance the magnet h draws down the pallets i and holds the ratchet wheel k and the separate ratchet wheel k^1 in the position shown in Fig. 26,

so that the point 60 on the printing lever m^1 will act as a wedge and force around the type wheel l, and the wheels k^1 and k one tooth at a time, as the printing lever is moved by the magnet m, but when the space (made by removing one tooth in the wheel k^1, Fig. 26) arrives at the point 60 the turning of the type wheel will cease because there is nothing for the point 60 to act against.

The printing pad p^2 may be a small rubber or elastic roller, so as to turn and present different sides to the impression.

To move the paper along a pawl u is employed and a roller or segment v. As the impression lever is raised the pawl u is forced upon the paper, holds the same, and feeds the strip along the required distance.

The lever v^1, Figs. 7, 9, and 10 is moved by a pin on the printing lever in a slot in the lever v^1, and a holding pawl w, Figs. 9 and 10, acts to prevent the paper drawing back.

In Fig. 5 the pawl u has an arm that is connected by a link 68 to the printing lever m^1, so that as the lever rises the paper is first caught by the pawl u, and then the parts move together as the lever v^1 is swung by the link 62; there is a slight looseness in the joint of the link 62 that allows the pawl u to be pressed upon the paper before the other parts move. The pawl may be made to slide and move the paper along in a shallow trough, and the end of the sliding pawl, coming against a stop as the printing lever and pawl are moved, gives the feed motion to the paper.

What I claim as my Invention and desire to secure by Letters Patent is,—

First. The pulsator c driven by friction in combination with the range of finger keys and the arms c^1, c^2, substantially as and for the purposes set forth.

Second. The revolving pulsator e in combination with the relay magnets and connections of the local and main line circuits, substantially as set forth for actuating the printing telegraph instruments in their respective circuits, substantially as set forth.

Third. The governor b^1 and flange 7 in combination with the circuit connections to the magnets of the motor, substantially as and for the purposes set forth.

Edison's Improvements in Printing Telegraphs.

Fourth. Two type wheels, Fig. 11, sliding endwise of the shaft, in combination with an electro-magnet to move such type wheels in one direction, and a spring or its equivalent to return the type wheels to their former position, substantially as set forth.

Fifth. An electro-magnet in the same circuit as the type wheel magnet, and operating to give end motion to two type wheels when the circuit is closed, in combination with a magnet in a separate circuit, to give the impression, substantially as set forth.

Sixth. The notched wheels r^2, r^3, Figs. 12 & 14, in combination with the type wheels l, l^2, and mechanism substantially as set forth, for moving the type wheels or the printing pad or shield, to select the type wheel from which the impression is to be made, substantially as set forth.

Seventh. Two type wheels with the characters of one in line with the spaces between the characters on the other, and a step-by-step movement that is operative when the electric circuit is both closed and opened, in combination with the notched wheels r^2, r^3, and mechanism for selecting the type wheel to be printed from, substantially as set forth.

Eighth. The conical faced notched wheels r^2, r^3, Figs. 14 and 15, in combination with the inclined stops r, r^1, and type wheels l, l^2, substantially as set forth.

Ninth. The swinging levers r, r^1, Figs. 12, 13, actuated by the printing lever m^1, in combination with the type wheels l, l^2, and notched wheels r^2, r^3, substantially as set forth.

Tenth. The combination of two type wheels and a printing lever, with mechanism moved by the printing lever, substantially as set forth, for printing from one type wheel when the type wheel circuit is open, and from the other when that circuit is closed, substantially as set forth.

Eleventh. A shifting movement derived from the printing lever, operating in one direction with a closed circuit, and in the other direction with an open circuit, substantially as set forth.

Twelfth. The bolt s, arm and notches 35, and fork 36, in combination with a type wheel or wheels, having two ranges of figures or letters, and the printing lever and wedge tooth s^3, as and for the purposes set forth.

Edison's Improvements in Printing Telegraphs.

Thirteenth. The cam 36 moved by the T lever o^1 and pins 30, 31, upon the printing lever, in combination with the type wheel l and sleeve o, substantially as and for the purposes set forth.

Fourteenth. The wheels r^2, r^3, Figs. 19, 22, projections r, r^1, and levers m^1, m^{11}, in combination with the type wheels l, l^2, substantially as set forth.

Fifteenth. Two separate printing levers and their respective magnets in the same or branch circuits, in combination with two type wheels positioned as specified, and mechanism substantially as set forth, for preventing an impression from one of the type wheels while the other is being printed from, substantially as set forth.

Sixteenth. The circuit closing arm 45, Figs. 20, 23, and connections to the respective magnets m, m^1, in combination with the printing levers m^1, m^{11}, type wheels l, l^2, and actuating mechanism, substantially as set forth.

Seventeenth. The printing lever and weight m^8 in combination with the type wheel and an electro-magnet, for the purposes and as set forth.

Eighteenth. The combination in one electric circuit of two or more type wheel magnets, and two or more printing magnets, and two or more weighted printing levers, substantially as set forth, whereby the printing will be effected by the same pulsation used to bring the type wheel to place, but only when the printing magnet has accumulated sufficient force to give a blow by the weighted printed levers, substantially as set forth.

Nineteenth. The air cushion, Fig. 25, applied to and combined with the printing lever and its magnet in a printing telegraph instrument, in the manner and for the purposes specified.

Twentieth. The arm o^7 and stop 50 upon the shaft g in combination with the arm o^4, teeth 54, and forked bar 53, moved by the printing lever m^1, the parts being arranged and operating, substantially as set forth.

Twenty-first. The wheel k^4 and tooth 60, actuated by the printing lever m^1 in combination with the type wheel l, wheel k, and pallets i, substantially as and for the purposes set forth.

Twenty-second. Adjusting the type wheel to the unison point by the movement of the printing lever, while the type wheel pallets are in the

Edison's Improvements in Printing Telegraphs.

opposite position to that which they occupy when the type wheel is being printed from, substantially as set forth.

Twenty-third. The pawl u upon the arm v^1, connected by the link 68 with the lever m^1 in combination with the slotted link 62, that swings the lever v^1 to feed the paper, substantially as specified. 5

Twenty-fourth. The spring 22, attached to the paper reel arms 20, and capable of being swung aside, in combination with the inking roller 21, sustained by arms from the cross bar a^8, as set forth.

Twenty-fifth. The electro-magnets, provided with slotted cores, and applied to a printing telegraph instrument, substantially as and for the purposes set forth. 10

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 21st day of October, A.D. 1872.

THOMAS A. EDISON. (L.S.)

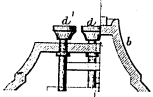
Witnesses, 15

CHA^s. H. SMITH, 121, Nassau St., New York, N.Y.

HAROLD SERRELL, " " "

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1872.

(5 SHEETS)
SHEET 1



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SPOTTISWOODE
1872

FIG. 1.

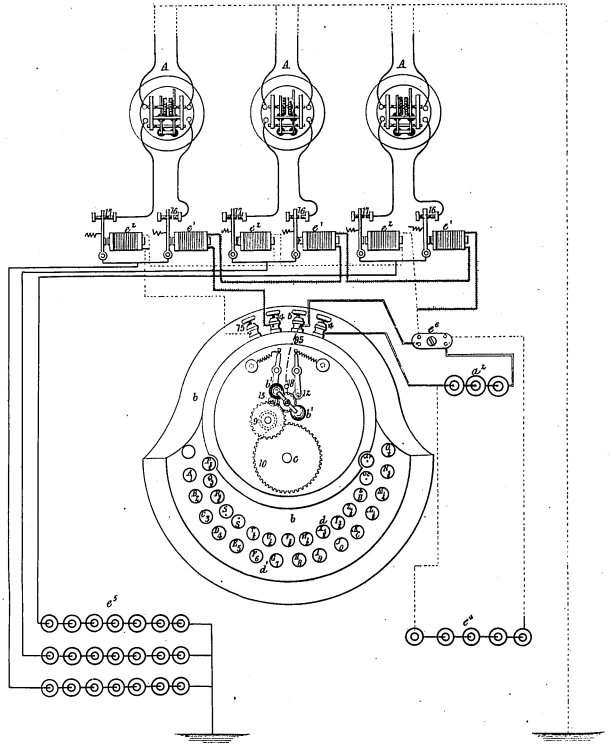


FIG. 3.

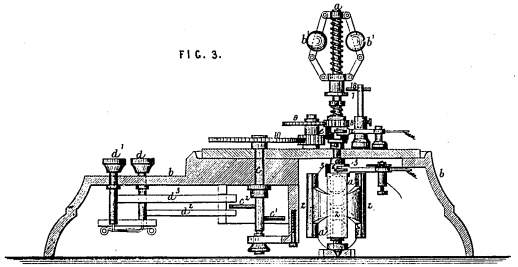
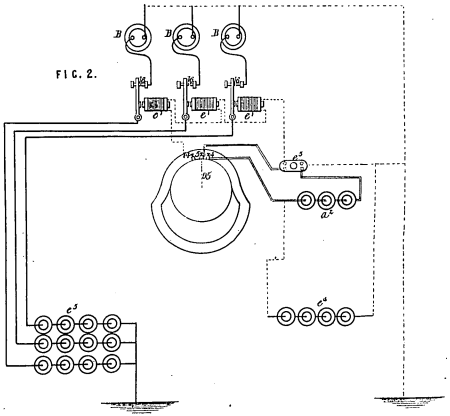


FIG. 2.



The tied drawing is not colored.

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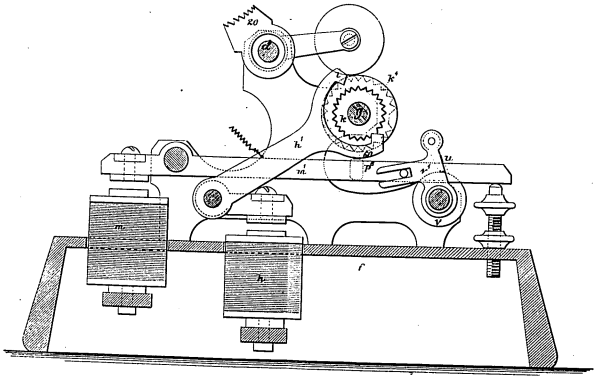
A.D. 1872. MAY 13. Nº 1453.
EDISON'S SPECIFICATION.

(5 SHEETS)
SHEET 2

FIG. 6.



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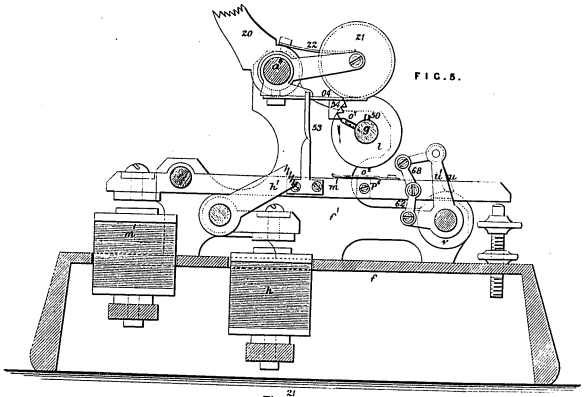
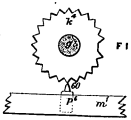


FIG. 26.



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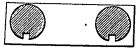
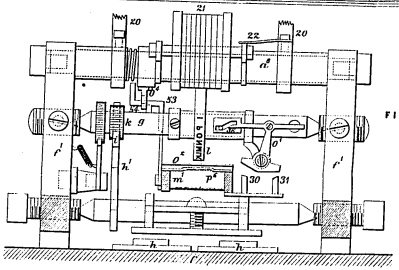


FIG. 8.



The tinted drawing is not colored.

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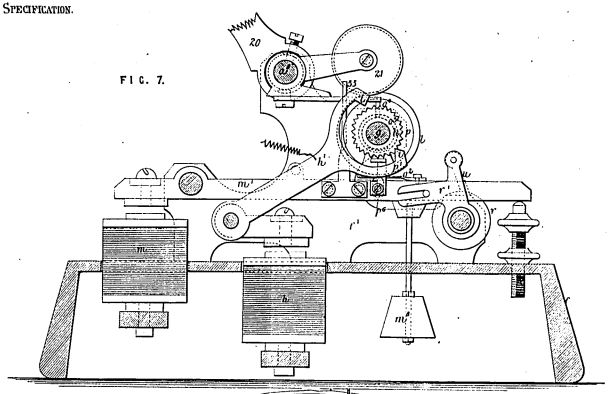
FIG. 7.



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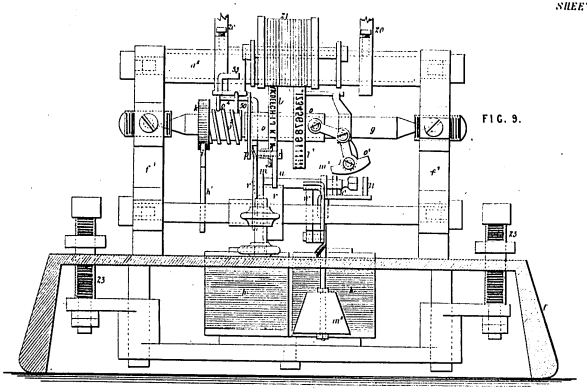


FIG. 10.

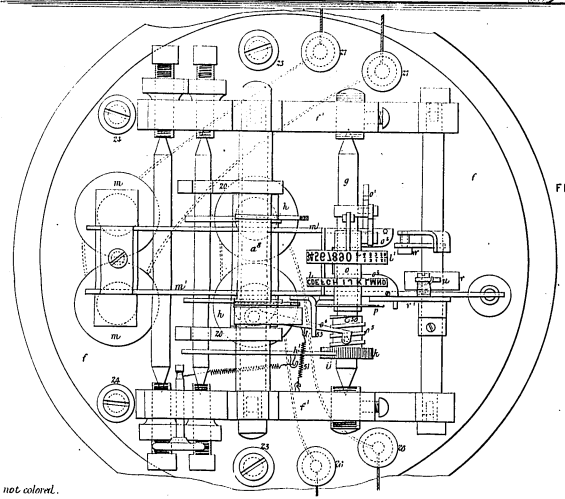
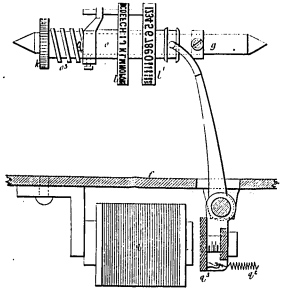


FIG. 11.



The filed drawing is not colored.

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A.D. 1872. MAY 13, Nº 1453.
EDISON'S SPECIFICATION.

(5 SHEETS)
SHEET 4.

FIG. 13.

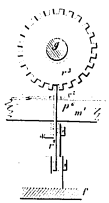


FIG. 12.

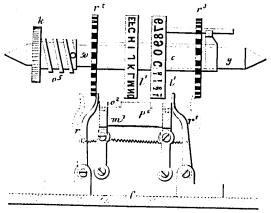


FIG. 18.

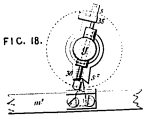
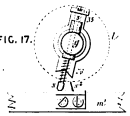


FIG. 17.



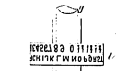


FIG. 16.

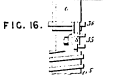


FIG. 24.

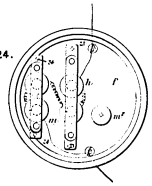


FIG. 15.

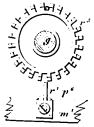


FIG. 14.

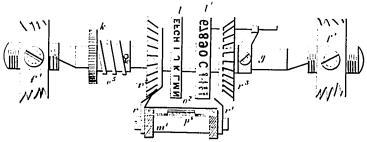
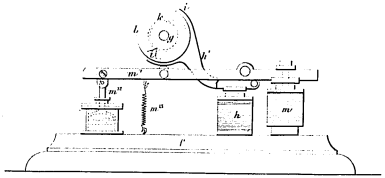


FIG. 25.



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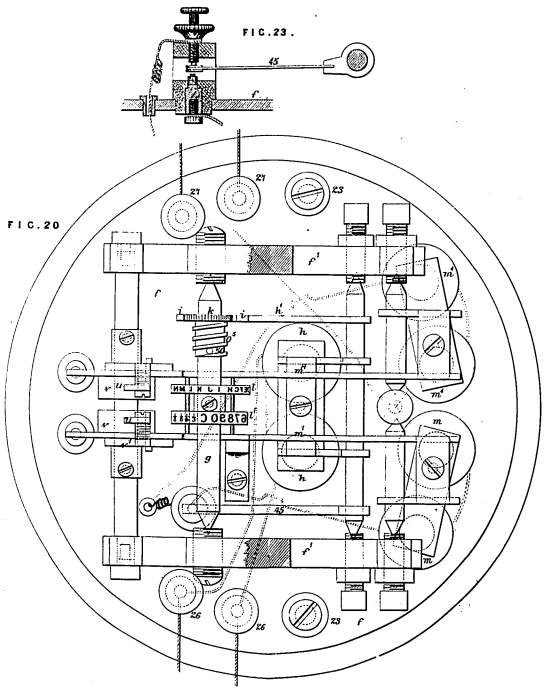

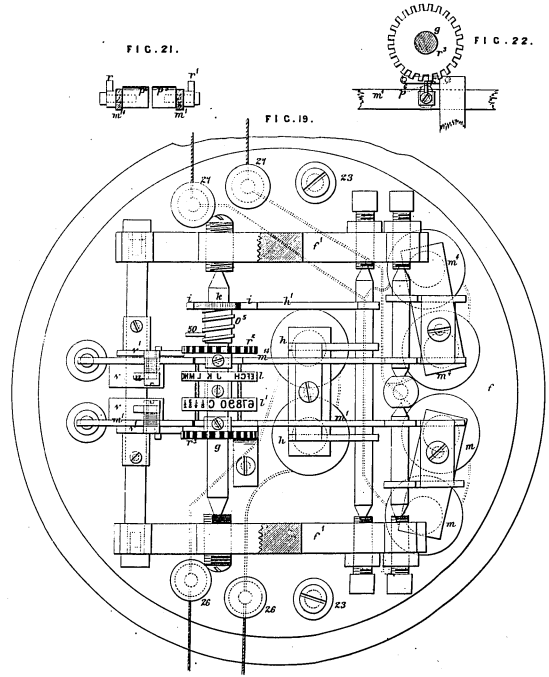

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Printers to the Queen's most Excellent Majesty 1872

A.D. 1873, *27th February.* N° 735.

Circuits and Instruments for Chemical Telegraphs.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN CIRCUITS AND INSTRUMENTS FOR CHEMICAL TELEGRAPHS."

Sealed the 20th May 1873, and dated the 27th February 1873.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents, with his Petition, on the 27th February 1873.

I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN CIRCUITS AND INSTRUMENTS FOR CHEMICAL TELEGRAPHS," to be as follows:—

On long telegraph lines the pulsations that produce the dots and dashes upon the chemical paper become so much attenuated as to be indistinct or to run into each other. The rapidity of the transmission is therefore lessened with the increase in the length of the line.

My improvements are to obtain greater rapidity in transmission in consequence of cutting off the tailings of the dots and dashes by neutralizing the attenuation of the pulsations.

I have discovered that the counter current set up in an electro-magnet or induction coil, when the circuit is broken, will neutralize the attenuation of the pulsation. I therefore introduce such magnet in a shunt or branch circuit, so that in the discharge of the magnetism the reverse current shall operate to clear the line of the tailings.

The electro-magnet or induction coil is sometimes introduced in a branch circuit from the line to the earth. At other times it is in a shunt contiguous to the receiving instrument.

Two or more stylus or pens, with shunt circuits and differing magnets to each, ensure legible characters in one of the several lines of characters.

At local stations drop copies can be taken by dividing the circuit, placing the magnet in the branch, or the same thing can be done in a branch circuit running to the earth, or the magnet may operate a sounder or call. A glass of water, with the ends of the line wire and the ends of local circuit wires to the receiving instrument, may be employed for drop copies. When a resistance is placed in the main line, and a circuit breaker is in the line operated with great rapidity so as to keep the line charged statically, the message will be sent by the perforated paper and stylus acting in a shunt that is connected with the line at both sides of the resistance.

The secondary current set up in an induction coil is employed for repeating a message. The primary circuit from the transmitting instrument acts in one coil, and that induces a secondary circuit in another coil connected with a receiving instrument. This device becomes an induction relay that acts with as great rapidity as the automatic transmitting instrument.

The secondary circuit may act in a second induction relay, or it may be used for drop copies, or for branch circuits running off from the main line. In order to clear the line from surplus electricity batteries are connected with the line at suitable distances apart, with their poles opposed to the main battery, but of much less power, and these batteries serve to neutralize or aid in neutralizing the tailings, and render the mark upon the chemical paper clear and distinct. These reaction batteries are either in the main line or in branch or shunt circuits.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 27th August 1873.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twenty-seventh day of February, in the year of our Lord One thousand eight hundred and seventy-three, in the thirty-sixth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Thomas Alva Edison, Her special licence that I, the said Thomas Alva Edison, my executors, administrators, and assigns, or such others as I, the said Thomas Alva Edison my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN CIRCUITS AND INSTRUMENTS FOR CHEMICAL TELEGRAPHS," upon the condition (amongst others) that I, the said Thomas Alva Edison, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Thomas Alva Edison, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being made to the Drawings hereunto annexed, and to the letters and figures marked thereon (that is to say):—

Before this Invention telegraphic circuits had been arranged with a rheostat to regulate the portion of the electric pulsation passing to the chemical paper, and allowing the other portions of the pulsation to pass along the main line or to go to the earth as a leakage. In these cases

the rheostat did not produce any counter current, and served only to direct portions of the electrical waves through the chemical paper, but the tailing and attenuation of the mark was not avoided, and upon long lines these marks usually ran together, because there was not sufficient time for the electric action to cease, or the line to free itself before another pulsation succeeded, and the line became surcharged.

In all cases it has been desired to obtain the most perfect insulation of the line to avoid the use of powerful batteries, and to lessen atmospheric influences. It has however been found that when the insulation is impaired by atmospheric influences the marks upon the chemical paper are more distinct, because the surplus electricity finds vent in currents to the earth, lessening the tailing.

When an electro-magnet is charged by a pulsation the electric action in the circuit of which the helix of the magnet forms a part is augmented, but when the main or line current is broken the magnet in discharging itself of the magnetism that has been induced sets up momentarily a counter current or one of opposite polarity.

I avail myself of these various conditions, and arrange the circuits in such a manner that the electro-magnets which are energized by the pulsation that makes the mark on the chemical paper serve to intensify the electric action upon that paper, but that the counter current, set up when the primary circuit is broken, shall neutralize the tailing or attenuation of the current by the discharge of the magnetism from the electro-magnet, thereby allowing for the use of very feeble currents, and rendering the marks upon the chemical paper sharp and clear, and I furthermore employ upon long lines one or more earth connections, in which are placed one or more electro-magnets, with or without rheostats to regulate the proportion of currents passing to the earth, such connections and electro-magnets serving to free the line from surplus electricity and by the reverse polar action, as the electro-magnet discharges itself, to free the line from any attenuation of the primary pulsations.

With long lines it is preferable to employ long electro-magnets, and the reverse, in order that the time occupied by the magnet in discharging its magnetism may be proportioned to the attenuation or tailing of the main current that is increased by the length of line.

In the Drawings Fig. 1 shows by a diagram the connections to effect this object. *a* is the transmitting instrument of the well known character,

in which a strip of perforated paper is drawn along between the drum and stylus or roller to open and close the main line circuit, and produce the pulsations of electricity that travel over the line in the direction of the arrows 3, and make a mark at the distant recording instrument *b* upon a strip of chemical paper drawn along between the stylus and roller. The current is divided, part passing by the wires 2, 2, in what is called a shunt, and in this is placed the electro-magnet *c*, or an induction coil. As each pulsation ceases in the main line a reverse current is set up in the shunt in the direction of the arrows 4 by the discharge of the magnetism of the core of the electro-magnet or induction coil. This cuts off any tailings in the pulsation of the main line, and prevents attenuation in the mark on the paper.

The electro-magnet or induction coil is sometimes introduced in a branch circuit from the line to the earth, as at *e*. At other times it is in a shunt contiguous to the receiving instrument.

Two or more styluses or pens with shunt circuits and differing magnets to each ensure legible characters in one of the several lines of characters. These are shown at f, f^1, f^2, Fig. 2, and it will be understood that the electrical conditions differing in the circuits to the different styluses that one of the lines of marks on the chemical paper is almost sure to be clear and legible, because of the electrical condition being correct.

At local stations drop copies can be taken by dividing the circuit, placing the magnet *c* in the branch, as at *g*, Fig. 1, or the same thing can be done in a branch circuit running to the earth, as at *e*, or the magnet may operate a sounder or call or a local circuit, as at *h*, Fig. 2, where the magnet *c* is represented as a relay operating in the local circuit from a battery *k* to the receiving instrument *b*. A glass of water, with the ends of the line wire and the ends of local circuit wires to the receiving instrument, may be employed for drop copies, as seen at *l*, Fig. 2.

When a resistance or rheostat R, Fig. 2, is placed in the main line, and a circuit breaker *o* is in the line operated with great rapidity by a revolving magnetic motor *p*, or otherwise, so as to keep the line statically charged, the message will be sent by the perforated paper, and the stylus acting in a shunt that is connected with the line at both sides of the resistance, the battery B charging the line directly through the

perforations of the paper, and producing pulsations of greater intensity than the static charge.

The secondary current set up in an induction coil is employed for repeating a message. The primary circuit from the transmitting instrument acts in one coil, and that induces a secondary circuit in another coil connected with a receiving instrument. This device becomes an induction relay that acts with as great rapidity as the automatic transmitting instrument.

In Figs. 3, 4, 5, 6, & 7 these induction relays are represented. The transmitting instrument *a*, battery B, receiving instrument *b*, and induction coil or electro-magnet *c*, to react and neutralize the tailings as the main line circuit is broken, are the same as before described, but the pulsations of electricity from the sending station only pass through an induction relay coil *l*, and that, by the well known principles of induction, sets up a current in the surrounding helix, Fig. 3, or connected helix *n*, Fig. 4, and this secondary or induced current either operates the receiving instrument, as seen in Figs. 5 and 6, or else it operates in a second induction coil l^1, Fig. 3, and that becomes a relay and sets up another current in the second induction coil n^1, and this operates in the receiving instrument.

Fig. 7 illustrates connections that may be made under this mode of operating:—New York is represented as the sending station. At New Brunswick a drop copy is being taken by the secondary or induced current from the induction relay. At Philadelphia the induction relay coil *n* is connected to earth at *v*, and to the line wire extending to Pittsburgh, and there operates in the receiving instrument. At Harrisburgh the line passes through an induction relay that sets up a current in the line reaching to a receiving instrument at Buffalo. At Baltimore a connection is shown from the relay coil *n* to Cincinnati, and the main pulsations from New York extend through to the receiving instrument at Washington.

In order to clear the line from surplus electricity reaction batteries are connected with the line at suitable distances apart, with their poles opposed to the main battery, but of much less power, and these batteries serve to neutralize or aid in neutralizing the tailings, and render the mark upon the chemical paper clear and distinct. These reaction

batteries are either in the main line or in branch or shunt circuits. These reaction batteries are marked *w*, and by reference to Figs. 6, 8, 9, 10, 11, 12, & 13, the arrangements and operations will be apparent.

In Fig. 8 there are several branch circuits h^2, in which are placed rheostats or resistances R that may be adjustable, and also batteries *w* that are of the proper power, and placed with the opposite pole to the line to that of the battery B, so that the line is operated upon in detail at suitable distances apart, say every one hundred miles more or less, and the line freed from tailing, and the same is opposed to the main current but not sufficiently powerful to neutralize the same, or to interfere with the transmission. These batteries *w* are so proportioned or adjusted as to be equal to the static current or electricity generated by the passage of the main current.

In Fig. 9 the same parts are employed, but the opposition batteries *w* are placed in the main line and distributed along the same. The branch circuits to the earth, with resistances R, act with the local opposition batteries to establish currents counter to the main current.

In Fig. 10 the effect produced is the same as before described, but in place of rheostats there are condensers i^2, and the opposition local batteries *w* acting upon the condensers establish an opposite polarity on the plates of the condensers that are connected with the line to the polarity of such plates when influenced by the transmitting battery, thereby neutralizing the tailings by charging the line statically in opposition to that from the main current.

The condensers may be connected with the opposition local batteries in the manner seen in Fig. 11, so that the plates that are connected to the line will be influenced by the other plates of the condenser that are connected with the earth and the other pole of the battery, the operation being similar to that before set forth.

In Fig. 12 the parts are the same in their operation as those before described, but instead of ordinary batteries cups *u*, containing platina or carbon strips and acidulated water, are employed, so that when the pulsation on the main line ceases to charge such cups a momentary reverse current is established to neutralize the tailings by instantly freeing the line of any electric charge.

Edison's Impts. in Circuits and Instruments for Chemical Telegraphs.

In Fig. 13 the line battery *w* is introduced at the receiving station to neutralize any local current that may leak from one insulator to another (upon the telegraph poles *v* that support the line wires), and tend to charge the line sufficiently to produce a light continuous mark upon the paper, the battery *w* not being sufficient to interfere with the pulsations for the message, although its poles are opposed to the same.

The electro-magnet or magnets *c* may be used at the transmitting end of the line either with or without the magnets at the receiving instrument.

In Fig. 14 this arrangement is shown. There is a rheostat or resistance R in the shunt 2, 2, and the electro-magnet or induction coil *c* is connected at both sides of the rheostat. Either pole of the battery B may be connected to the line. The effect of this is that when the circuit is open part of the current passes upon the line and part returns to the battery through the magnet *c*, the rheostat being adjusted to direct the required quantity through the magnet.

When the circuit is broken the reactionary discharge of the magnet acts in the opposite direction to the static discharge of the line, and neutralizes it or restores the normal condition of the line instantly, and thereby prevents the tailings at the receiving instrument.

What I claim as my Invention, and desire to secure by Letters Patent, is,—

First. An electro-magnet or induction coil applied with a chemical telegraph to neutralize the tailings in the main line by the discharge of induced magnetism.

Second. Two or more styluses to mark on a strip of chemical paper, and the combination therewith of shunt circuits and induction coils, or magnets of different sizes.

Third. A rapid pulsator *o*, to charge the line constantly through a rheostat R, combined with the transmitting instrument, in a shunt of the main line connected at both sides of the rheostat.

Fourth. A coil in which a secondary current is set up by a primary coil, in combination with connections from that secondary coil to the line or a receiving instrument.

Edison's Impts. in Circuits and Instruments for Chemical Telegraphs.

Fifth. One or more batteries in the main line, or connected therewith, having their poles opposed to the main line current to neutralize tailings in the pulsations.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Twenty-fourth day of July, A.D. 1873.

THOMAS ALVA EDISON. (L.S.)

Witnesses,

CHA^S. H. SMITH,
121, Nassau St.
New York.

HAROLD SERRELL,
121, Nassau St.,
New York.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1873.

A.D.1873. FEB. 27. Nº 735.
EDISON'S SPECIFICATION.

(2 SHEETS)
SHEET 1

FIG. 1.

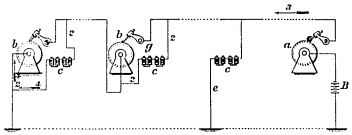


FIG. 2.

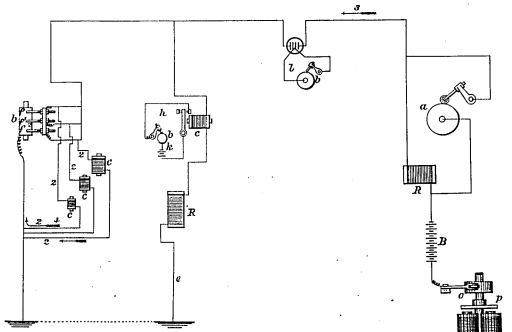


FIG. 14.

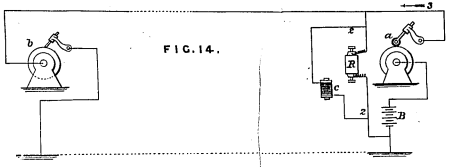


FIG. 3.

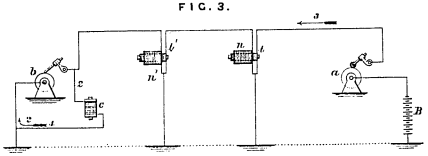


FIG. 4.

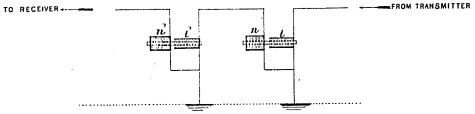


FIG. 5.

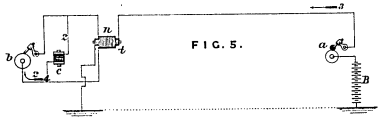


FIG. 6.

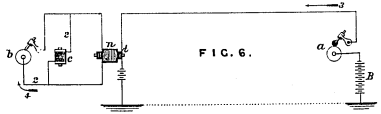
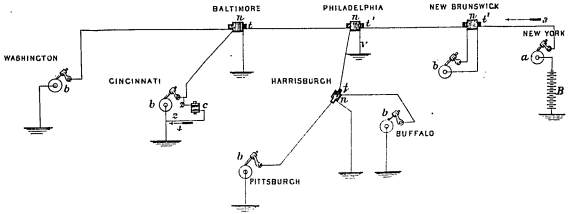


FIG. 7.



The filed drawing is not colored.

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Printers to the Queen's most Excellent Majesty 1873

A.D. 1873. FEB. 27. Nº735.
EDISON'S. SPECIFICATION.

(2 SHEETS)
SHEET 2

FIG. 8.

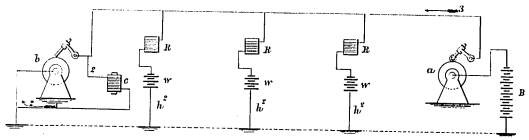


FIG. 9.

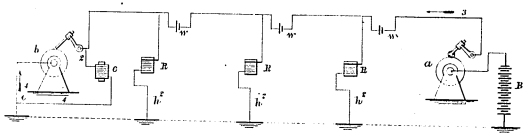


FIG. 10.

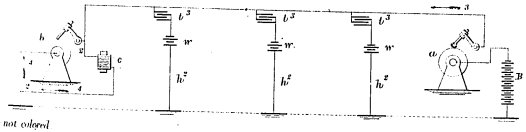


FIG. 11.

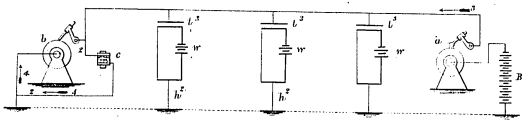


FIG. 12.

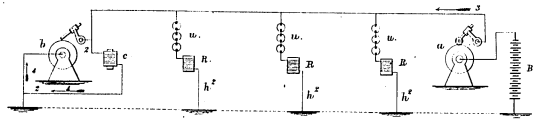
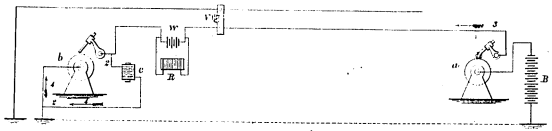


FIG. 13.



The filed drawing is not colored

Drawn on Stone by Malby & Sons

LONDON Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE
Printers to the Queen's most Excellent Majesty 1873

A.D. 1873, 25th April. N° 1508.

Electric Telegraphs.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "Improvements in Electric Telegraphs."

Sealed the 5th August 1873, and dated the 25th April 1873.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents, with his Petition, on the 25th April 1873.

I, Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, do hereby declare the nature of the said Invention for "Improvements in Electric Telegraphs," to be as follows:—

In cables and long telegraph lines there is a limit to the speed with which perfect signals can be transmitted and received, whether the receiving instrument consists of an electro-magnet, a galvanometer, a relay, or a chemical telegraph instrument. This limit in speed arises from the fact that the moment the line or cable is charged by the battery being connected a static charge is instantly set up which is in an

opposite direction to the dynamic charge, and the tendency is to defer the reception of the signal at the distant station, and at the moment of breaking the battery connection the static charge disperses by dividing at the centre of resistance and going in both directions, one part going to the ground at the transmitting station in a direction opposed to the battery, and the other part going towards the receiving instrument in the same direction as the previous current from the battery. This electrical condition is of sufficient duration to render the signals unintelligible at the receiving instrument after a certain speed is attained. The time of discharge is directly proportioned to the resistance at the points of discharge at the ends of the line, and the result is that the speed of the instruments is limited to the speed with which the line will free itself through the channels aforesaid.

My Invention relates to the discovery of a method of neutralizing the effects of the static charge in any length of line or cable by balancing the electric forces, and the discovery of a point of no electric tension or zero as regards the static charge, so that the receiving instrument when located at that point will be operated by the rise of tension produced by a pulsation that is connected at such receiving instrument and made as instantly and definitely operative as the pulsation given at the transmitting station. I obtain this point of no tension by forming at the receiving end an artificial line, having an equal resistance and electrostatic capacity or capacity for producing static charges as that of the cable or land line, and connect this with the line or cable, and place between the cable and the artificial line the receiving instrument, which hence is in the centre of resistance and static accumulation; when this balance is obtained the signals are received perfect, and the rapidity is governed only by the strength of the battery. The artificial line is made with an adjustable rheostat; liquid in a tube is preferable.

I connect between the receiving instrument and the earth one or more condensers or other accumulators of static electricity, which are made adjustable by having them in sections, and bringing one or more sections in or out by a switch so as to increase or decrease the static charge from the artificial cable; it may also be done by placing a very high adjustable resistance coil between one leaf of the condenser and the artificial line. I maintain a very low resistance between the line and the ground at the transmitting station so as to discharge the static current at this end as rapidly as possible.

The mode which I prefer is to keep my transmitting battery in circuit at all times, and include in the same circuit another battery of equal power with opposite poles, so that when both are in there is no current generated, and the resistance of the wire to earth is no more than the resistance of the battery.

The transmission of a pulsation is made when the circuit is closed through the perforation in the paper, or otherwise, so as to short circuit or shunt the neutralizing battery and send a current upon the line.

The current at receiving paper is shunted through a resistance so as to preserve a constant and equal resistance which the chemical receiving paper does not give, owing to being more damp in one place than another. In balancing the resistance and static current the resistance of the instrument is to be added to the line, and the resistance of the two equalized by the same amount of resistance in the artificial cable or line.

If the receiving instrument is out of the centre of resistance towards the line the pulsations will be weakened by the static charge acting against the pulsation; but if the instrument is towards the artificial cable on the other side of the zero point the signals or characters will be slightly prolonged owing to the static charge discharging in the same direction as the current. It is at this point that I prefer to place the instrument, because by placing an electro-magnet in the shunt of the receiving instrument I obtain enough counter discharge from that magnet to cut off this prolongation locally, and this discharge from the magnet will not interfere with the line that has only a local effect on the receiving instrument to prevent tailing on the chemical paper.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 25th October 1873.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twenty-fifth day of April, in the year of our

Lord One thousand eight hundred and seventy-three, in the thirty-sixth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Thomas Alva Edison, Her special licence that I, the said Thomas Alva Edison, my executors, administrators, and assigns, or such others as I, the said Thomas Alva Edison, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN ELECTRIC TELEGRAPHS," upon the condition (amongst others) that I, the said Thomas Alva Edison, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Thomas Alva Edison, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being made to the Drawing hereunto annexed, and to the letters and figures marked thereon (that is to say):—

This Invention is for increasing the speed of transmission and neutralizing the effect of static electricity at the receiving instrument. An artificial line is employed at the opposite side of the receiving instrument to the cable or main line, hence between such instrument and the earth connection. This artificial line is made with a rheostat or resistance, and with a condenser or other accumulator of electricity, and the artificial line is so adjusted as to resistance and static charge as to equal the line or cable; the consequence is that the receiving instrument is placed at a neutral point or zero as regards electric tension and static charge, from which the static charges will discharge or equalize itself both ways, and the message will be received with great rapidity and reliability, according to the pulsations from the transmitting station.

In the Drawing Figure 1 illustrates my Invention in the form that I find most generally available. The batteries *a* and *b* are connected in

opposite positions, the positive poles being towards each other, and the negative poles connected to the ground *g* and line *l* respectively. The transmitting instrument *c* is in a circuit *d* to the battery *b*, in which circuit *d* is a resistance *e*. When the circuit *d* is broken, the two batteries *a*, *b*, neutralize each other, and there is no charge sent on the line, but when the circuit *d* is closed through a perforation in the paper or by a finger key or otherwise, the battery *b* is short circuited, and the battery *a* being unbalanced sends a pulsation on the line. The artificial line between the receiving instrument *f* and the earth g^1 is made by introducing a resistance or rheostat at *r*, preferably a tube containing liquid with adjustable points. This rheostat is made to balance, or equal or nearly equal the resistance of the line *l*, and the instrument *f* and the condenser *s* or other accumulator of static electricity is of a capacity to about equal that of the line, hence the receiving instrument will occupy a zero or neutral point in regard to the static charge from which the static charges will discharge both ways to *g* and g^1. The condenser or accumulator *s* should be in sections to bring in a greater or less number of sections by switches.

When the receiving instrument is chemical, the paper is preferably prepared by dipping it in a solution of at least one pound of iodide of potassium in one gallon of water, to which has been added a small quantity of flour. This paper cannot be maintained at uniform moisture, hence its resistance to the passage of electricity varies; this is compensated for by the shunt circuit *t*, in which is a resistance *u* sufficient to direct the necessary amount of electricity to the paper to make the mark and allow the remainder to pass to the artificial line, thus the varying condition of the paper does not change the resistance of the line.

When an electro-magnet is energized and the circuit broken, a pulsation is set up in the opposite direction to that passing into such magnet; I avail of this to prevent tailings upon the chemical paper by so applying the electro-magnet that its discharge will aid in restoring the line or instrument to a normal condition instantly, and at *v* I have shown an electro-magnet for this purpose. It will be seen that this electro-magnet will discharge itself within a short local circuit containing the receiving instrument, and that the reactionary current therefrom moving in the opposite direction to the main current frees the receiving instrument from any tailings caused by the discharge of static electricity,

and this magnet *v* may be employed in many places to effect the object before named even when there is not an artificial line.

In some instances with very long lines there may be intermediate artificial lines arranged as aforesaid, or reactionary magnets with branch circuits to the earth to either receive drop copies in such branch circuits or to free the line of static electricity, and aid in obtaining the signals perfectly at the last receiving station with the greatest rapidity.

Figs. 2 and 3 represent the same parts as before described, but in Fig. 2 only a single battery is shown, and the resistance *c* is between the line and the earth to regulate the proportion of electricity sent over the line by adjusting such rheostat to prevent too great return to the battery through such rheostat.

From the foregoing it will be understood that what is to be attained is the instant restoration of the line at the receiving instrument to a normal electric condition after it has been disturbed by the passage of a pulsation of electricity, so that the speed will not be lessened by false or reactionary currents, and that the chemical paper will only be marked with a dot or dash when the transmitting instrument is operative. In some lines this condition is promoted by the devices shown in Figs. 3 and 4, and these are preferably used in addition to the balanced circuit at the receiving end, as shown in Fig. 3, or may be used separately therefrom as represented in Fig. 4. The transmitting instrument *c*, circuit *d*, from the battery *a*, and the rheostat *e* are as before mentioned, and the battery may be arranged with either its positive or negative to the line, and there is a condenser *h*, Fig. 3, or one or more induction coils or electro-magnets *h*, Fig. 4, connected in the shunt *d* at both sides of the rheostat *e*. The effect of this is that when the circuit is opened through the perforation of the transmitting paper the current passes upon the line and also through the magnet or condenser *h* back to the other pole of the battery, the rheostat *e* diverting the required quantity. As the circuit *d* is broken by the intervening paper, the reactionary discharge or condition of opposite polarity takes place from the magnet or condenser, and acting in the opposite direction either neutralizes the static discharge of the line or becomes a path for its return to the earth connection of the battery, so that tailings or prolongations of the marks on the chemical paper at the receiving instrument are effectually prevented. In long lines an electro-magnet or

resistance *r* may be introduced in a branch circuit f^1 to the earth to react upon the line to effect the same object, and a small battery may be introduced in said branch with its poles opposed to the main current that would pass over that branch, and thereby aid the reactionary effect of the magnet in clearing the line, and lessen the tailings upon the chemical paper.

Claims.

I claim as my Invention,—

First. The artificial line on the opposite side of the receiving instrument to the line or cable for positioning the receiving instrument at a neutral point for the purposes set forth.

Second. An electro-magnet or condenser positioned in relation to the receiving or the transmitting instrument, substantially as set forth, so that the reactionary discharge from said magnet shall aid in restoring the normal condition of the line cable or receiving instrument.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Sixteenth day of September, A.D. 1873.

THOMAS ALVA EDISON. (L.S.)

Witnesses,

Chas. H. Smith, 121 Nassau St., N.Y.

Geo. T. Pinckney, " " " "

LONDON:
Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1873.

A.D. 1873. April 25, № 1508.
EDISON'S' SPECIFICATION.

(1 SHEET)

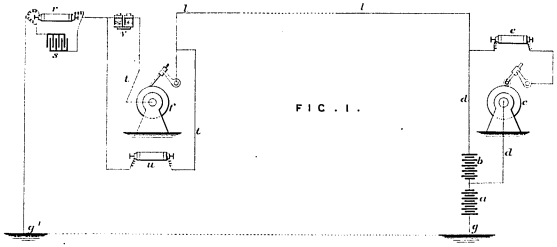


FIG. 1.

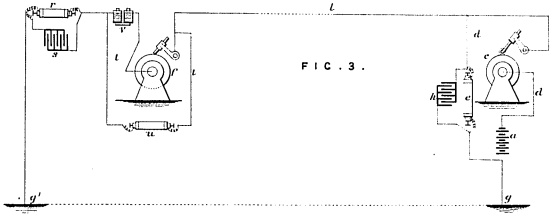


FIG. 3.

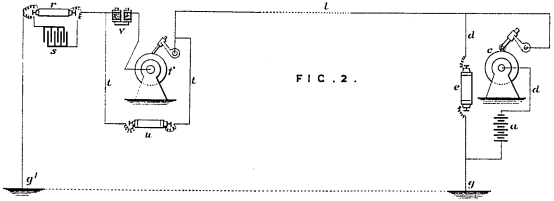


FIG. 2.

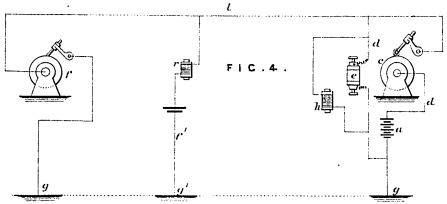


FIG. 4.

The filed drawing is not colored.

Drawn on Stone by Malby & Son.

London Printed by George Edward Eyre and William Spottiswoode
Printers to the Queen's most Excellent Majesty 1873

A.D. 1873, 11*th* September. N° 2988.

Perforated Telegraphic Paper.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "Improvements in Perforated Paper for Telegraphic Purposes, and in Means for Receiving and Transmitting with the same."

Sealed the 3rd March 1874, and dated the 11th September 1873.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents, with his Petition, on the 11th September 1873.

I, Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, do hereby declare the nature of the said Invention for "Improvements in Perforated Paper for Telegraphic Purposes, and in Means for Receiving and Transmitting with the same," to be as follows:—

The paper instead of being perforated in telegraphic characters is perforated in groups that represent Roman or block letters, or other characters, and the message is received upon chemical paper in dots that either touch each other or are sufficiently close to clearly represent

by their aggregation the letters or characters transmitted, thus making the automatic telegraph strip as convenient as the printed message, and obtaining the rapidity of the former, and avoiding the risks of the inaccuracies of the latter.

The paper is perforated, one letter or character at a time, by an instrument operated by finger keys substantially similar to that shewn in English Patent, No. 1751, A.D. 1872, except that the punches are massed together, preferably in a square, and the connections between each key and the punches are such as to select and operate such of the punches as will perforate the paper to represent the letter or character upon the finger key. It is preferable to employ twenty-five punches in a square of five each way.

The transmission from the perforated strip may be by as many lines of telegraph wires as there are rows (five) of perforations, so that there may be a transmitting stylus to each row of perforations, and also a pen or wire stylus to mark on the chemical paper, and these pens are to be sufficiently close together to produce the letter transmitted in consequence of the contiguity of the marks. The message can be made through one line wire by having the transmitting paper at one end and the receiving paper at the other, and travelling at proper speed; and a series of spring fingers upon a shaft at right angles to the shaft of the roller for the paper, so that these spring fingers draw across the perforated paper, and make contact through the perforations, and at the same instant the chemical paper is marked in the corresponding spot by the spring, pen, or wire drawn across the same, and moving synchronously. Of course the revolving spring finger styluses and pens revolve very rapidly, and the respective strips of paper are drawn along comparatively slowly, the respective parts moving at the same speed or nearly so.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 4th March 1874.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Eleventh day of September, in the year of our Lord One thousand eight hundred and seventy-three, in the thirty-seventh year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Thomas Alva Edison, Her special licence that I, the said Thomas Alva Edison, my executors, administrators, and assigns, or such others as I, the said Thomas Alva Edison, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN PERFORATED PAPER FOR TELEGRAPHIC PURPOSES, AND IN MEANS FOR RECEIVING AND TRANSMITTING WITH THE SAME," upon the condition (amongst others) that I, the said Thomas Alva Edison, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Thomas Alva Edison, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being made to the Drawing hereto annexed, and to the letters and figures marked thereon (that is to say):—

In the Morse system of telegraphy the operator frequently receives the message by sound, and writes the same out as received.

In the printing telegraph system the printed slip is usually delivered as received.

In the ordinary automatic system the paper has to be punched or composed, and at the receiving station the message on the chemical paper has to be translated and written out by hand, or printed by a key printing instrument.

Each system has its defects or disadvantages. The Morse system is slow, and requires a large number of wires. The printing telegraphs

Edison's Improvements in Perforated Telegraphic Paper.

are expensive, liable to inaccuracies and injury, and limited in speed to the fingering of the keys. The automatic system is rapid on the line, but the composing of the message and the writing of it out at the receiving station are comparatively slow operations.

The object I have in view is to print the message chemically, thereby the message, as received upon a strip of paper, is ready to be folded and sent to its destination, and the rapidity is equal to any automatic transmission.

I accomplish this object by perforating the strip of paper used for transmitting with groups of holes, representing by each group a letter or character, the perforations being arranged to produce as nearly as possible the block or Roman letters or characters.

The transmission of the message by the line wires may be in the usual manner by a roller or stylus, and a line wire to each row of perforations, so that if there are five rows of perforations there will be five stylus points or rollers, each connected to a line wire, and at the receiving instrument there will be five pens or stylus points near together; and the letter received will be in dots corresponding to the position of the perforations in the transmitting paper, and by their aggregation in groups the letters will be clearly delineated, and formed almost as perfect as printed characters, so that the strip of chemical paper can be delivered, and the re-writing or printing of the message dispensed with.

The message as received being the counterpart of that transmitted the perforated paper at the transmitting station becomes a perfect record of the message, and the line can be worked up to its utmost capacity, because the paper can be perforated for transmitting about as rapidly as an ordinary printing telegraph can be operated, and as many perforating operators and machines can be used as are necessary for the work that is to be done on the lines.

I have herein indicated the mode of using this improvement with five line wires, but I contemplate to use the transmitting paper, perforated as herein described, with transmitting and receiving mechanism that will operate with only one line wire.

In the Drawing Fig. 1 represents a piece of paper with perforations, and adapted to use in transmitting.

Edison's Improvements in Perforated Telegraphic Paper.

Fig. 2 shows the chemical paper with the same word printed thereupon by the dots running together, or being sufficiently close to each other, to show the respective letters.

Fig. 3 is a plan of a portion of the perforating machine.

Fig. 4 is an elevation endwise of the punches, and Fig. 5 is a partial section longitudinally.

I find that five lines of perforations are the most convenient for producing perforations in imitation of block letters or characters, and have shown and described such, but I am not limited in that respect.

Reference is hereby made to Letters Patent, No. 1751, granted in Great Britain, June 10th, A.D. 1872, for a machine for perforating paper for telegraphic purposes, which, with the modifications herein set forth, is adapted to punching the characters in the strip of transmitting paper.

Instead of having two lines of punches *i*, *i*, as in aforesaid Patent, these punches *i*, *i*, are twenty-five in number positioned in a square of five each way, and as close together as convenient. Each punch is connected with its slide plate *k*, and these slide plates *k* are side by side, and supported in the frame of the machine, so that they can be moved endwise with facility, and actuate the punches to which they are connected respectively. The punches slide in the plate *m*, and *n* is the die plate, as in said Patent.

There might be a spring to each slide plate *k* and punch *i*, but I have shown a lever k^1 passing through mortices in the plates *k*, and provided with a spring to draw all the punches and slide plates back to their normal position after they have been actuated. If the punches are separate from the slide plates each row may be provided with a lever *l* and spring *o* to return or draw back the punches, and said levers *l* act within notches in the punches, as shown.

The shoulders or projections 8 are provided upon the slide plates contiguous to the respective pressers *e*, and these projections 8 are only upon such of the slide plates that require to be moved by the presser to which they are adjacent to operate the punches required to perforate the letter corresponding to the one on the finger key *a*, that is, connected to the particular presser *e*, as in aforesaid Patent; and I remark that the slide bars *c* and connecting cams *f* or forks to move the pressers *e* by

Edison's Improvements in Perforated Telegraphic Paper.

the finger keys *a* may be similar to those shown in said Patent; and the lever u^1, feeding clamp *t*, pawl *u*, rack bar *v*, and pawl 10 are similar to the parts shown, and operate in the manner described in the aforesaid Patent, and therefore do not require further description.

From the illustration given in Fig. 1 the general character of the groups of perforations will be apparent, and in the square of twenty-five punches the proper ones can easily be selected to perforate any given letter or character sufficiently like block letters to be reliably read at the receiving station on the chemical paper.

CLAIMS.

I claim as my Invention,—

First. A strip of paper containing groups of perforations representing letters or characters for use in transmitting telegraphic messages to be received upon chemical paper in imitation of printed characters.

Second. Mechanism for making groups of perforations in a strip of paper in imitation of letters or characters, the same consisting of punches massed together in a square or nearly so, and mechanism intervening between such punches and the finger keys for selecting from such mass of punches those that are required for perforating characters corresponding with the characters upon the respective finger keys, substantially as set forth.

In witness whereof, I have hereunto set my hand and seal this Thirteenth day of February, A.D. 1874.

THOMAS ALVA EDISON. (L.S.)

Witnesses,

CHAS. H. SMITH, 121, Nassau St., New York.

GEO. T. PINCKNEY, " " " " "

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1874.

FIG. 5.

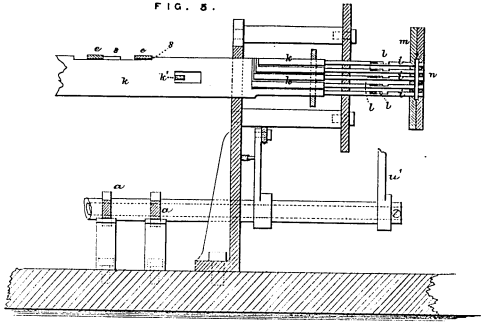


FIG. 4.

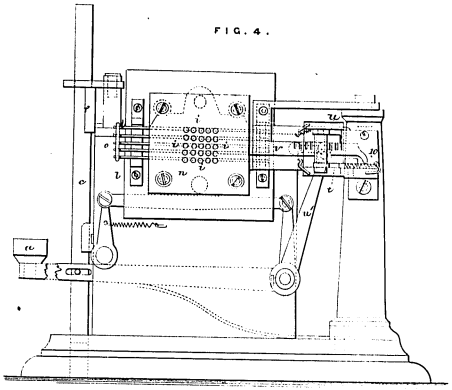


FIG. 3.

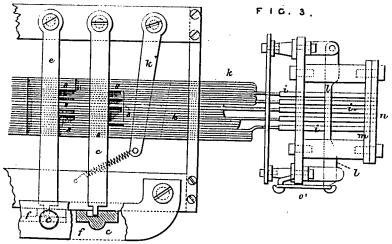


FIG. 1.

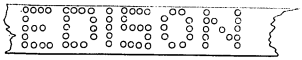


FIG. 2.

The filed drawing is not coloral.

Drawn on Stone by Malby & Sons

London Printed by George Edward Eyre and William Spottiswoode
Printers to the Queen's most Excellent Majesty 1874

A.D. 1875, *2nd February.* N° 384.

Multiplex Telegraphs.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN DUPLEX AND MULTIPLEX TELEGRAPHS."

Sealed the 25th March 1875, and dated the 2nd February 1875.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents, with his Petition, on the 2nd February 1875.

I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN DUPLEX AND MULTIPLEX TELEGRAPHS," to be as follows:—

The objects of this Invention are,—

1st. To enable two operators, one at each terminal station, to transmit simultaneously over one wire, and two others, one at each of such stations, to receive such messages, and in this respect my Invention is an improvement in duplex telegraphs.

A

2nd. To enable four operators, two at each terminal station, to transmit signals, and four other operators, two at each terminal station, to receive the messages, without either interfering necessarily with the other, and to use only one line wire in so doing. This portion of my Invention is designated a quadruplex or multiplex telegraph.

3rd. To allow either operator to signal the distant station so that the message may be repeated to rectify any inaccuracies or omissions.

4th. To repeat a message received over one wire by either the duplex or quadruplex telegraph into another circuit to send the same to another or distant station.

I remark that the duplex and quadruplex telegraphs can be used by the number of persons named, or they can be used singly by one operator at each end; and furthermore, that by bearing in mind the general principles of operation herein set forth the details of the arrangements of the batteries and metallic circuit connections will be apparent to an electrician.

One of the persons sending a message employs a key that is constructed so that it does not break the circuit, but that it connects more or less of the battery to the line; thus one operator works a distant instrument by a rise and fall of the electrical tension or energy. The other operator has a key that is made to reverse the circuit connections without breaking the continuity of circuit, and thus his message is indicated by a change in the polarity of the current sent regardless of the tension or energy of the battery power. These keys of the sending station are either operated directly by hand or preferably by an electro-magnet, a local circuit and a finger key for each, and both ends of the line are similarly provided with two transmitting keys, batteries, and circuit connections, and also with the receiving instruments next specified; but I remark that the receiving instruments are also capable of use in duplex telegraphy under systems of transmission heretofore employed, wherein the rise and fall of tension produce the respective indications at the two receiving instruments.

The instrumentalities at each end for receiving the messages consist, 1st, of a receiving magnet; 2nd, of a polarized receiving magnet; 3rd, of an artificial line; 4th, of adjustable rheostats or resistances; and 5th, of local circuits containing batteries and electro-magnets forming

the instruments for receiving the message by sound by a "Morse receiver," or in any other convenient manner.

The instruments that are required for either the quadruplex or the duplex system of receiving are selected and arranged with reference to the transmitting devices employed. With the duplex system operated by rise and fall of tension, as aforesaid, the polarized relay will not be required, but the receiving magnet is to be placed at a point that is neutral to the message sent from that station but where it will be influenced by the message received. To this end the artificial line composed of a rheostat preferably with a condenser in a shunt around the rheostat is arranged so that its discharge may compensate the static discharge from the line, and this artificial line is at one side of the receiving instrument or instruments, and the line connection at the other; and the pulsations sent from the home station will be balanced in the receiving instrument at that station, but such receiving instrument will respond to the pulsations from the distant station because the distant pulsations are unbalanced.

The receiving magnet is sometimes made with two helices on one core, and one helix is in the artificial line and the other in the main line, and they are so wound as to oppose each other, and hence the core is not magnetized by the outgoing current, but it is by the current from the distant station operating in the one helix. The polarized receiving magnet employed in the quadruplex telegraph is similarly arranged and positioned so as to be uninfluenced by the current sent, but to respond to the change of polarity in the current received; and when made with four helices around the two cores the instrument becomes a differential polarized relay or magnet.

When the condenser is used in a shunt around the rheostat, either in the artificial line or between the receiving instrument and main line, its charge and discharge as the circuit is opened or closed neutralizes or compensates for the effect of the static charge and discharge that takes place at that same time, because the condenser is arranged so as to discharge in opposition to the static discharge.

In the receiving instruments aforesaid when arranged for the quadruplex telegraph it is preferable to arrange the local circuit that is worked by such receiving instrument so that the sounder is operated by the unbalanced force of a second local battery when the first local circuit is

broken by the armature of such receiving instrument, thereby the sounder will be more distinct in its response to the pulsation on the line.

The main battery of the line is subdivided into two portions of unequal power for the object herein-before named, and one portion is always upon the line and the other portion is applied or removed by the key of one of the operators to increase or lessen the electrical energy. With this battery it is preferable that a resistance be inserted in a branch passing around the battery to the key, arranged to present the same resistance to currents from the distant station that that portion of the battery itself presents when it is connected into the circuit so as to maintain equality of resistance. Either an induction coil or else cups of acidulated water with similar poles may be used in place of the condenser before named when the devices are positioned, so that the discharge from the coil or the cups on the opening of the circuit opposes, compensates for the effect of, or neutralizes the static discharge of the line.

Where two helices are used upon one core and the line and artificial lines pass through those helices as aforesaid there may be a third helix on the same core between the said two helices, and this third helix will operate the receiving instrument by the induced current in the said third helix.

A compound differential and polarized magnet may be made use of in the quadruplex telegraph. In this instrument there are two armatures, one to respond to change of polarity and the other to change of electrical tension or energy from the distant sending station, as aforesaid.

When the duplex or quadruplex receiving instrument is arranged to act as a repeater to send the message on to another station the polarized magnet is delicately adjusted so that the magnetized tongue is energized to respond to delicate changes in the polarity of the cores, and this polarized tongue opens and closes the circuit for the relay and operates the same either directly or through an electro-magnet and armature with circuit closing or reversing springs to act in the relay circuit. These circuit connections are arranged so that on long lines the duplex telegraph may repeat the messages into another duplex telegraph to another distant station, or the quadruplex telegraph may be made to

operate automatically at an intermediate station as a relay to and from a distant station on long lines, the principles of operation as aforesaid being borne in mind, the receiving instruments being made to operate the relay instruments and circuits instead of acting upon a sounder. At the intermediate or relay station switches will generally be used to facilitate the adjustment of the line and to throw in or out the relay connections so as to work from or to either end, or to allow the end stations to communicate with each other by the relay on long lines.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 31st July 1875.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Second day of February, in the year of our Lord One thousand eight hundred and seventy-five, in the thirty-eighth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Thomas Alva Edison, Her special licence that I, the said Thomas Alva Edison, my executors, administrators, and assigns, or such others as I, the said Thomas Alva Edison, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN DUPLEX AND MULTIPLEX TELEGRAPHS," upon the condition (amongst others) that I, the said Thomas Alva Edison, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

Edison's Improvements in Multiplex Telegraphs.

NOW KNOW YE, that I, the said Thomas Alva Edison, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being made to the Drawings hereto annexed, and to the letters and figures marked thereon (that is to say):—

The objects of this Invention are,—

First. To enable two operators, one at each terminal station, to transmit simultaneously over one wire, and two others, one at each of such stations, to receive such messages, and in this respect my Invention is an improvement in duplex telegraphs.

Second. To enable four operators, two at each terminal station, to transmit signals, and four other operators, two at each terminal station, to receive the messages without either interfering necessarily with the other, and to use only one line wire in so doing. This portion of my Invention is designated a quadruplex or multiplex telegraph.

Third. To allow either operator to signal the distant station so that the message may be repeated to rectify any inaccuracies or omissions.

Fourth. To repeat a message received over one wire by either the duplex or quadruplex telegraph into another circuit, to send the same to another or distant station.

I remark that the duplex and quadruplex telegraphs can be used by the number of persons named, or they can be used singly by one operator at each end; and furthermore, that by bearing in mind the general principles of operation herein set forth, the details of the arrangements of the batteries and metallic circuit connections will be apparent to an electrician.

One of the persons sending a message employs a key that is constructed so that it does not break the circuit, but so that it connects more or less of the battery to the line; thus one operator works a distant instrument by a rise and fall of the electrical tension or energy; the other operator has a key that is made to reverse the circuit connections without breaking the continuity of circuit and thus his message is indicated by a change in the polarity of the current sent, regardless of the tension or energy of the battery power. These keys of the sending station, are either operated directly by hand, or preferably by an electro-magnet, a local circuit, and a finger key for each, and both ends of the

Edison's Improvements in Multiplex Telegraphs.

line are similarly provided with two transmitting keys, batteries, and circuit connections, and also with receiving instruments next specified, but I remark that the receiving instruments are also capable of use in duplex telegraphing under systems of transmission heretofore employed, wherein the rise and fall of tension produce the respective indications at the two receiving instruments.

The instrumentalities at each end for receiving the messages consist, first, of a receiving magnet; second, of a polarized receiving magnet; third, of an artificial line; fourth, of adjustable rheostats or resistances; and fifth, of local circuits containing batteries and electro-magnets forming the instruments for receiving the message by sound by a "Morse receiver," or in any other convenient manner.

The instruments that are required for either the quadruplex or the duplex system of receiving are selected and arranged with reference to the transmitting devices employed. With the duplex system operated by rise and fall of tension as aforesaid, the polarized relay will not be required, but the receiving magnet is to be placed at a point that is neutral to the message sent from that station, but where it will be influenced by the message received. To this end the artificial line composed of a rheostat, preferably with a condenser in a shunt around the rheostat, is arranged so that its discharge may compensate the static discharge from the line, and this artificial line is at one side of the receiving instrument or instruments, and the line connections at the other, and the pulsations sent from the home station will be balanced in the receiving instrument at that station, but such receiving instrument will respond to the pulsations from the distant station because the distant pulsations are unbalanced.

The receiving magnet is sometimes made with two helices on one core, and one helix is in the artificial line, and the other in the main line, and they are so wound as to oppose each other, and hence the core is not magnetized by the outgoing current, but it is by the current from the distant station operating in the one helix. The polarized receiving magnet employed in the quadruplex telegraph is similarly arranged and positioned so as be uninfluenced by the current sent, but to respond to the change of polarity in the current received, and when made with four helices around the two cores, the instrument becomes a differential polarized relay or magnet.

When the condenser is used in a shunt around the rheostat, either in the artificial line or between the receiving instrument and main line, its charge and discharge, as the circuit is opened or closed, neutralizes or compensates for the effect of the static charge and discharge that takes place at that same time because the condenser is arranged so as to discharge in opposition to the static discharge.

In the receiving instruments aforesaid, when arranged for the quadruplex telegraph, it is preferable to arrange the local circuit that is worked by such receiving instrument so that the sounder is operated by the unbalanced force of a second local battery when the first local circuit is broken by the armature of such receiving instrument, thereby the sounder will be more distinct in its response to the pulsations on the line.

The main battery of the line is subdivided into two portions of unequal power for the object herein-before named, and one portion is always upon the line, and the other portion is applied or removed by the key of one of the operators to increase or lessen the electrical energy; with this battery it is preferable that a resistance be inserted in a branch passing around the battery to the key, arranged to present the same resistance to currents from the distant station that that portion of the battery itself presents when it is connected into the circuit so as to maintain equality of resistance. Either an induction coil or else cups of acidulated water with similar poles may be used in place of the condenser before named, when the devices are positioned so that the discharge from the coil or the cups on the opening of the circuit opposes, compensates for the effect of, or neutralizes the static discharge of the line.

Where two helices are used upon one core, and the line and artificial line pass through those helices as aforesaid, there may be a third helix on the same core between the said two helices, and this third helix will operate the receiving instrument by the induced current in the said third helix.

A compound differential and polarized magnet may be made use of in the quadruplex telegraph. In this instrument there are two armatures, one to respond to change of polarity, and the other to change of electrical tension or energy from the distant sending station, as aforesaid.

When the duplex or quadruplex receiving instrument is arranged to act as a repeater to send the message on to another station the polarized

magnet is delicately adjusted, so that the magnetized tongue is energized to respond to delicate changes in the polarity of the cores, and this polarized tongue opens and closes the circuit for the relay, and operates the same either directly or through an elelectro-magnet and armature, with circuit closing or reversing springs to act in the relay circuit. These circuit connections are arranged so that on long lines the duplex telegraph may repeat the messages into another duplex telegraph to another distant station; or the quadruplex telegraph may be made to operate automatically at an intermediate station as a relay to and from a distant station on long lines, the principles of operation as aforesaid being borne in mind, the receiving instruments being made to operate the relay instruments and circuits instead of acting upon a sounder. At the intermediate or relay station switches will generally be used to facilitate the adjustment of the line, and to throw in or out the relay connections so as to work from or to either end, or to allow the end stations to communicate with each other by the relay on long lines.

The essential instrumentalities are,—

First. The line wire, marked on the Drawing L.

Second. The battery, marked B.

Third. A circuit preserving key K that serves to connect and disconnect portions of the battery with the line, and increase or decrease the electrical energy, or as otherwise called, produce a rise and fall of the electrical tension. This key K is made with an insulated spring 2 upon it that comes into contact with the metal of the key when in a normal condition, and so maintains a metallic circuit through the key from the respective wires, but when the key is depressed the spring 2 comes against an adjusting screw 3, to which another circuit wire from other other portions of the battery is connected, hence, the circuit through the key is never broken, but the new circuit through the screw 3 is closed; thereby there is no time when the circuit through this key is entirely interrupted, and the wires to the battery are arranged so that more or less of the battery is applied to the line by this movement of the key.

Fourth. A circuit preserving and pole changing key, called a reversing key, and marked R, K. This is constructed with a spring 4 acting (like the spring 2) against the screw 5, and there is a second insulated arm 6, either at right angles to the key, as shown in the Drawing, for greater

clearness, or in line with the main portion of the key, and there is a second insulated spring 7 to this arm 6, and a circuit closing screw 8. The construction of this is such that when in a position of rest one pole of the battery, say the positive, is connected to the line, and the negative to the earth; but when the key R, K, is moved the negative of the battery is connected to the line, and the positive to the earth, and this is done as aforesaid without the circuit being entirely broken at any point.

Fifth. An electro-magnet that operates by a rise of electrical tension, but is not influenced by reversing the polarity of the current nor by the weaker current that is constantly on the line; this is marked M. The spring of its armature is adjusted so as to respond with the rise of electrical tension, but not to respond to the weak constant current in the line.

Sixth. An electro-magnet with a magnetized or polarized tongue *i*, and known as a differential or polarized magnet, and marked D, M. This magnet is not operated by a rise and fall of the electrical energy, but only by a change of polarity, whether the current is weak or strong.

Seventh. Rheostats that serve to determine the quantity of electricity flowing through one circuit, and to divert the remainder through another circuit. These are marked R, and numbered for convenience of reference.

The appliances before described are either well known to electricians or will be understood by the foregoing description.

The ground or earth connections or plates are marked G.

In practice I arrange the rheostats and circuits as will be hereafter described, so that the line is always charged, and the two operators at one end send to the distant station electrical pulsations, one operator's pulsations being an increase of electrical energy that at the distant station energizes the electro-magnet M. The other operator reverses the polarity of the current, whether that current is strong or weak, and the magnet D, M, responds at the distant station, but the circuits and electrical actions are so balanced that the receiving instruments M and D, M, are not affected in the least by the currents sent out from the home station, but they are free to respond to the currents coming from

the distant stations, hence two, four, six, or eight persons can operate over one wire, half of them being engaged in sending and the other half in receiving.

Having thus defined the general principles of operation, the details will be easily understood by reference to the Figures of the Drawing successively.

The keys K and R, K, Figure 1, may be operated directly by hand, but I prefer that the operator use the finger keys *a* and *b*, batteries a^1, b^1, local circuit wires and electro-magnets *c* and *d*, with armatures to move these keys K and R, K, respectively. The main battery B has a wire 10 from the key K that divides the battery into a larger portion 11 and a smaller portion 12. When the key K is at rest the battery 12 is connected to the line L through the connections 5, 6, 7, 13, 14, and R^1, and to the earth through the connections 10, K, 2, wire 16, 8, R, K, 4, and 17. When the key K is depressed the entire battery 11 and 12 is placed on the line by connecting from 3 to earth G through 2, 16, 8, R, K, 4, and 17. Now if the key R, K, is operated either at the same time as K or separately the polarity is reversed, whether the electrical tension is high or low. Suppose the current aforesaid was positive to line and negative to earth, then if R, K, is depressed 4 will be separated from R, K, and 7 from 6, and the positive current will go from 5 to earth G through 4 and 17, while the negative will be connected to the line L from 3 or K by spring 2, wire 16 by 8, 7, 13, and 14, and R^1 to line L.

It is to be understood that the instruments at the distant station are the counterparts of those shown in Fig. 1; and having now described how the pulsations of different polarity and of rise and fall of electrical tension are sent it will be apparent that they will at the distant station operate the magnet M or the polarized magnet D, M, the currents passing from the line L by 20, M, 21, D, M, R^2, 23, R^2, 15, 13, to earth through R, K, and its connections; a portion however passes by R^1 and 14, and also a portion by R^1 to earth, according to the relative resistances of the various routes.

It is now necessary to describe why the pulsations sent do not operate the receiving instruments at the home or sending end of the line.

The instruments M and D, M, are at a neutral point to the pulsations sent, because the electric current divides half going by 14, the other

half by 15, the rheostats R^3 and R^1 being adjusted to offer the same resistance as the rheostat R^1 and the line and distant instruments, hence between 20 and 23 what is known as a "bridge" is formed and the electric forces of the outgoing current opposing each other equally the instruments M and D, M, are not affected. The rheostat R^2 serves to divert a portion of the current passing between 20 and 23 into the condenser C^1, and upon the principles known to electricians the condenser reacts or sets up a reverse current when the current is lessened or augmented, thereby the effect in the instrument of the static charge and discharge due to the passage of the distant signalling current over such line are neutralized by the counter-discharges from the condenser.

A secondary battery S, B, Fig. 16, composed of two or more cups containing acidulated water and poles of the same materials may be used in the "bridge" to effect the same object of neutralizing static discharge from the line of the of the incoming current by an opposing or counter current set up when the electrical condition is changed. The condenser C^2 arranged around the extremities of the rheostat R^4 which forms the artificial line is for the purpose of generating an inductive current to balance that due to the static induction of the line. The rheostat R^5 is for the purpose of regulating (by increasing and decreasing the resistance) the length and strength of the inductive current from C^2 to enable perfect compensation to be obtained on various wires and especially upon long circuits.

The functions performed by the condenser C^2 will be equally as well performed by inserting an electro-magnet C^1 in the circuit 15, as shown in Fig. 16. The rheostat R^2, Fig. 1, is adjusted to afford the same resistance as the battery B, hence when the operators at one station are balancing the outgoing currents upon the receiving apparatus M and D, M, at that station by the adjustment of R^4 and R^2 the switch 13 at the distant station which is in connection with the line is to be turned to the right so as to disconnect the battery B from the line and allow the earth connection to pass through R^2; thus the battery at the distant station will not interfere with the proper balancing of the outgoing current.

The receiving instruments M and D, M, may be observed by the receiving operators and the message read either by sound or in any other known way, but usually it will be best to use these as the relays to the receiving instrument proper, and they are so shown. The magnet M

operates by its armature lever, the local circuit from the battery f, in which is placed the electro-magnet g, and this in turn operates a second local circuit from the battery f^1, in which is the receiving instrument g^1, which will usually be a sounder; the circuit of f will close when M ceases to attract its armature, and the circuit of f^1 will close when g is demagnetized, hence the receiving instruments g^1 and M will pulsate exactly in harmony, and as the armature of g is not so delicately adjusted as the armature of M there will not be any false pulsation reach g^1 as sometimes occurs in M, when the polarity of the current is reversed.

The same effects will be produced by the circuits shown in Figs. 2, 3, and 4. In Fig. 2 the battery f will be short circuited through the armature of the magnet M when the current does not act in M, and hence the battery f will not act in g, but when the armature of M is attracted the circuit is broken and the battery f has no other route, but is obliged to act in g, hence the armatures of g and M respond simultaneously.

If the batteries f and f^1 be both connected to the receiving magnet g, as shown in Fig. 3, and in reverse, so that they balance each other when the circuits of the two batteries are closed the electro-magnet g will not be energized, but this electro-magnet g will respond to the battery f^1 simultaneously with the magnet M, because when the armature of M is attracted the circuit of the battery f is opened, and said battery f ceases to neutralize the effect of the battery f^1. The same effect will be produced by connecting the battery f to the wire between the helices of the magnet g, as seen in Fig. 4, and winding those helices so that the battery current dividing and acting in both helices will produce similar polarity of the cores, hence the magnetism will be neutralized, while both circuits from the battery f are closed, but when one circuit is broken by the movement of the armature of M the battery current acts in only one helix and attracts the armature at the same time as the armature of M moves. The polarized tongue i of the electro-magnet D, M, is shown in Fig. 1 as acting as a relay to the local circuit containing the battery h and receiving magnet or sounder k, and in Fig. 5 this electro-magnet k acts a relay to the second local circuit and battery l, in which is placed the receiving magnet or sounder n.

In Fig. 6 the differential polarized magnet D, M, instead of being in the same bridge 20, 23, with the receiving magnet M as before is

made as a compound differential polarized magnet, in which there are four helices so wound that the outgoing current from 14 will operate in the helices G1, G2, while that from 15 will act in the helices G3, G4; and these helices being wound in opposite directions the cores passing through G1, G3, and G2, G4, respectively, will not be magnetized, the magnetizing actions being opposed to each other, hence the polarized tongue *i* between the cores will not be moved one way or the other, but the incoming current from the distant station will pass from L through G2, G1, to 14, thence through the bridge wire containing M, and also through R^1 and R^2 to earth through the transmitting keys; owing to the great resistance of R^1 (which should be equal to the line) a very small portion of the distant currents passes to earth by this route. The distant current in passing through the helices G2 & G1 gives the respective cores a polarity to attract the tongue *i* one way or the other so that the tongue responds to the change of polarity resulting from operating the key R, K, (Fig. 1) at the distant station.

In Fig. 7 the same arrangements of transmitting keys, as in Fig. 1, are shown, and the compound polarized magnet D, M, described in connection with Fig. 6, is introduced near the dividing points of the wires 14 and 15, and the electro-magnet M is made compound, having two helices wound in opposite directions, so that the outgoing currents neutralize each other in their tendency to magnetize the soft iron core, passing through both helices; thereby magnetism is not produced by the outgoing current, but the current coming from the distant station, passing in one direction through the helix 26 and back in the other direction through the core 27 produces magnetism in the core, so that the armature of M responds to the rise and fall of electrical tension of the current sent by the key K at the distant station, and the polarized tongue *i* of the differential magnet D, M, responds, as aforesaid, to the reversal of the circuit connections by the key R, K, at the distant station.

The rheostats and condensers in Figs. 6, 7, 8, and 9, are introduced for the same purpose, and are adjusted to act in the same manner as the same instruments shown and described in connection with Fig. 1, and marked with the same letters of reference.

A modification in the construction of the magnet is shown in Fig. 9, in which the coils or helices G1, G2, G3, and G4, connected with the wires 14 and 15 act, as described in connection with Figs. 6 and 7, to

move the magnetized tongue *i* by the change of polarity; but there is an armature M added, the spring of which is adjusted so that the armature responds to rise and fall of electrical tension, thus dispensing with the magnet M and making the one compound magnet, shown in this Fig. 9, respond to the change of polarity or electrical tension, or both, at the distant station; but this compound magnet is uninfluenced by the currents sent out at that station because they are balanced in their actions therein, as before described. Electro-magnets *o*, *o*', placed in branch or shunt circuits around the receiving magnet, set up counter secondary currents to neutralize the secondary or induction discharge of the electro-magnet D, M.

In Fig. 8 a modification of the circuit wires is shown. The magnet M and differential magnet D, M, are the same as in Fig. 7, but there are two artificial lines with rheostats R^1, R^2, and condensers C^2, and these are separately connected to the respective magnets and to earth, so that the outgoing currents can be balanced in their action in D, M, by one artificial line to G and balanced in the electro-magnet M by the other artificial line to G^1 independent of each other.

In Fig. 10 connections are shown that correspond to those shown in Figs. 1 and 5, so far as the receiving portion of the apparatus; the transmitting keys K and R, K, are somewhat differently arranged. The battery is compound, part being opposed to the other part. The key R, K, in a position of rest is open, and the key K is closed, hence the portions 30 and 32 of the battery are short circuited through K and do not go upon the line, and the batteries 31 and 33 still act in the line, but 31 overpowers and more than neutralizes 33, so that the preponderating force from 31 on the line is negative, the earth being connected to positive; now, if the key R, K, be closed the portions 30 and 31 of the battery are short circuited, allowing the portion 33 to act and reverse the polarity of the current, as the positive pole of 33 is to the line. If the key K is depressed the short circuits of 30 and 32 are broken, and these portions 30 and 32 of the battery act in the line, but 30 contains a large excess in the number of cells and acts with 31 to neutralize 32 and 33 and produce a rise of electrical tension on the line; hence by this arrangement the rise and fall of tension and the reversal of the polarity of the currents are attained without the peculiar keys shown in Figs. 1 and 7. D, M, Fig. 11, is a polarized relay having the

line wire L attached to the cross wire connecting the two spools together. The other ends are connected, one to a resistance coil R^2 and the other to an ordinary electro-magnet *o*. The resistance of *o* is equal to R^2. Now when the current is made to circulate permanently through the two coils of the polarized relay D, M, and through *o* and R^2, its effect is balanced in the polarized relay M, as it passes in opposite directions through its two coils, but the magnet *o* is charged. Now, if the current be interrupted or suddenly decreased in strength the iron cores of *o* set up an induced current in the helices surrounding it, and this current circulating within the circuit formed of O, R^2, and the coils of the polarized relay D, M, passes in the proper direction through D, M, to make its cores magnetic, and the tongue is thrown to one side. If now the circuit be closed or the strength of the current increased the magnet *o* will in the act of charging set up another induction current, which now circulates in the opposite direction, and throws the tongue of the polarized relay in the opposite direction. The tongue is to be adjusted so that the weak current from battery 12 at the distant station will not produce sufficient induced current by its passage through *o* to affect the tongue of D, M, but only when the battery 11 is put to line; hence the polarized relay will respond only to currents transmitted from a strong battery 11. M is a double coil relay, which works by the weak current from 12. The main current passes through the coil 27 in one direction, and if the transmitter K is quiet works the lever, and the message is received. I use a repeating sounder *g* to repeat the signals to the receiving sounder g^1 for the reason that in signalling with battery 11 the armature lever of M receives a forward jerk, and would give a false signal were it not for the repeating sounder *g*, which owing to sluggishness, and having to be fully charged, &c., does not repeat the false signal on *g*.

I will now describe the method by which I prevent the battery 11 from affecting M. Suppose the battery 12 is disconnected, and the battery 11 is put to line by the key K, the polarized relay responds and the lever of M would also, were it not for the fact that owing to the rapidity with which the polarized tongue *i* moves, a second circuit is closed which contains a resistance coil R^3 and a battery *h* adjusted in such a manner that a current passes through the second coil 26 of M equal to that passing through 27 from the battery 11; hence the effect of the strong current from that battery 11 is balanced in M. Within this equating circuit is

placed a relay *k*, which operates a receiving magnet *n*, from which the signals of the polarized relay D, M, are copied.

It is obvious that the current from the battery 11 will pass through the coil 27 on magnet M before the equating circuit can be closed, and the effect is to give the lever of the relay armature a quick forward movement, but the effect of this is neutralized by employing the repeating sounder *g* before described.

In Fig. 13 the polarized relay is dispensed with, and two separate relays used, both of which respond to the heavy battery, while O responds only to the weak battery. M^1 and D are both adjusted with high tension of armature spring. One message received upon M is indicated by the sounder *g*, while the other message is received upon M^1 and sounder n^1. The magnet D is used to close the balancing circuit to balance the effect of the large battery within the coils of M. The magnet M^1 might be taken out of the main line, and inserted in the balanced circuit *h*, R^3 and produce the same effect.

Another modification is shown in Fig. 12. D is adjusted to respond to the strong currents when the armature lever is away from the magnet. The main circuit is completed which first passes through the coil of D, then to the earth through a resistance of several hundred ohms in R^4. Another route to the earth is through shunt wire *u* to armature lever of D, thence through point c^6 to the coil M on the relay. In this position the relay responds to the weak currents from the distant station. The tension on the retractile spring of the armature of D being great, and the cores some distance from its armature does not so respond, but when the strong battery is put to line the lever of D is attracted, and the strong current instead of passing through the coil M now passes through the resistance R^3 and coil *k*; the effect of its passage through the coil R^3 is to weaken the total current nearly as much as it was increased by addition of battery power, so that the electro-magnet M does not respond to strong currents.

Fig. 14 shows a plan, and Fig. 15 is a perspective view of devices for magnetizing the tongue *i* of the differential magnets D, M, and adjusting the polarity of this tongue *i*. This tongue *i* is connected at one end to the iron standard *s*, and contiguous to this standard *s* is a magnet *t*; said magnet may be a permanent bar magnet, as in Fig. 15, or an electro-magnet polarized by a local battery u^8, and the magnetism

passes from t by induction through s to the tongue i, and hence the tongue i can be more or less strongly magnetized by adjusting the magnet t nearer to or farther from the standard s, or by adjusting the rheostat R.

Fig. 17 shows connections similar to those shown in Fig. 1, with the exception of the magnet M and the electro-magnet M, X, R, for balancing the effect of the static charge and discharge. The magnet M is provided with an extra magnet X acting on the opposite side of the armature lever, but with a tendency to move the lever in the same direction as M. This magnet X is placed in the condenser circuit and receives momentary magnetism at the moment when the current from the distant station is increased, decreased, or changed in the direction of the flow. The object of this extra magnet is to produce a more powerful compensation for the effect of the static charges and discharges upon the waves, as they pass over the wire from the distant station and through M.

When the line is very long and of high resistance and great electro-static capacity, the first portion of a dash from the distant station will be very weak owing to the static current of the line. The effect of the condenser acting both within the triangular circuit as well as through the magnet X is to supply as it were the current lost of the static phenomenon of the line. M, X, and M^1, X^1, are two electro-magnets of equal size, resistance, and power arranged in 14 and 15 in place of R^1 and R^2, as in Fig. 1. Opposite M^1, X^1, is placed another magnet R, X, which may, by the adjusting device p, be made to approach or recede from M^1, X^1. This magnet R, X, is placed in a second artificial circuit. When the battery at that station is augmented or reversed the magnet R, X, becomes powerfully charged, and this magnetism acting upon the cores of M^1, X^1, sets up a strong momentary induction current within the triangular circuit in a direction, as regards the receiving instruments M, and D, M, contrary to that of the static current from the line, hence a balance is obtained and the instruments remain unaffected by the outgoing current. M, X, is used for the purpose of preventing the two angular wires from being unequal, and thus setting up inductive currents on the passage of the distant current.

It is obvious that if the line be very long and of great electro-static capacity, that the resistance of R^2 may be made so small, that a very

powerful current will pass through R, X. The exact balance can also be obtained by moving the magnet R, X, to or from M^1, X^1.

In Fig. 18 the same parts are shown as in Figs 1 and 10, except that the tongue i works to close a circuit from the battery h to either of the electro-magnets k or n, and these move the reversing key R, K, similar to that shown in Figs. 1 and 7. The battery B is connected with this reversing key similarly to that before described, hence a change of polarity in D, M, moves the key R, K, first one way and then the other, and thus the message is relayed or repeated into a new circuit, the object of this being to use the duplex or quadruplex systems before described on as long lines as convenient, and then to make the magnets D, M, and M, repeat the messages automatically into new circuits extending still further.

The entire apparatus and connections for repeating as aforesaid are shown in the diagram, Fig. 10, which although it appears complicated is very simple, one line L for instance comes from New York to one set of instruments at an intermediate station, say, Buffalo, and the other line L, L, extends to the distant instruments, say at Chicago, in the other direction.

The keys and instruments are duplicated and exactly the same as shown in Figs. 1 and 5, only there are two distinct set of instruments.

Suppose that a message over the wire L acts by rise and fall of tension in the relay magnet M, and that the message is repeated into the sounder or receiving instrument g^1, as before described, if the switch 40 in the local circuit of the battery f^1 is closed the message goes no further, but if the switch 40 is open the circuit of the battery f^1 extends to the electro-magnet c, the switch of the key a being closed; thereby the message received at M on one line is repeated by c and K into the next line. So in like manner the message received from New York in the differential magnet D, M, and repeated in the sounder n will go no farther if the switch 42 is closed, but if the switch 42 is open the message will be repeated to Chicago at the key b by the magnet d and key R, K; that reverses the circuit in the same manner as if the finger key b were operated. Of course by closing the switch 41 the message coming over the line L, L, from Chicago and received in M will be repeated to New York, and the same thing will occur in relation to the message received in D, M, from Chicago if the

switch 43 is closed. Thus, one or more messages may be automatically repeated in long lines without interfering with the working of the other portions of the quadruplex instruments in either direction from the intermediate station.

In Fig. 20 the polarized magnet D, M, and circuit wires are the same as have before been described, but the magnet M that responds to rise and fall of electrical tension is slightly varied. The armature 84 is polarized, and swings between the cores of the electro-magnet M, and at the outer end the tongue is between the springs 82 and 83, and these springs are strong enough to hold the tongue stationary, except when the electro-magnet M is highly energized by increase of current from the sending station; when at rest the current from the battery 85 passes by the springs 82, 83, and block 86 back to the battery, but when the current is increased enough to draw the armature 84 towards the spring 82 that is moved away from 86 the short circuit through 86 is broken, and the current directed through the receiving magnet *g*, and it returns through spring 83 to the battery, and if the polarity of the current is changed and the strength of current remains the armature 84 flies over against 83, and moves it so suddenly that the magnet *g* will not have time to demagnetize by the momentary contact of both the short circuit springs with the block 86.

What I claim as my Invention and desire to secure by Letters Patent is,—

First. The combination in telegraph circuits of keys that produce a rise or fall of the electrical tension, keys that change the polarity of the current connected with the line, receiving magnets operated by rise and fall of electrical tension, and polarized magnets that operate by change of polarity of the electrical current, substantially as set forth.

Second. The combination with electro-magnets operated by rise and fall of electrical tension of relay circuits, batteries, and electro-magnetic receiving instruments or sounders, substantially as set forth.

Third. The combination with a polarized relay magnet operated in the telegraphic circuit by change of polarity of the current of relay circuits, batteries, and receiving electro-magnet or sounder, substantially as set forth.

Fourth. In a telegraph arranged to operate by rise and fall of tension and change of polarity of the electrical currents the use of condensers,

rheostats, or induction coils to neutralize the static charges and discharges, substantially as set forth.

Fifth. In a quadruplex repeater the combination of the two receiving instruments in one circuit with the two magnets and transmitting device in the other circuit, connected so that signals made in one circuit will be repeated to the receiving instruments in the other circuit, and vice versa.

Sixth. In a quadruplex telegraph a main line circuit divided and provided with local batteries and circuits that operate the repeating instruments, substantially as set forth.

Seventh. The combination in a quadruplex repeating telegraph of switches or circuit connections for dividing the local circuits to allow each quadruplex line to work independently, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Sixth day of July, A.D. 1875.

THOMAS ALVA EDISON. (L.S.)

Witnesses.

CHA^S. H. SMITH, 121, Nassau St., New York.

HAROLD SERRELL, " " " " "

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(2 SHEETS)
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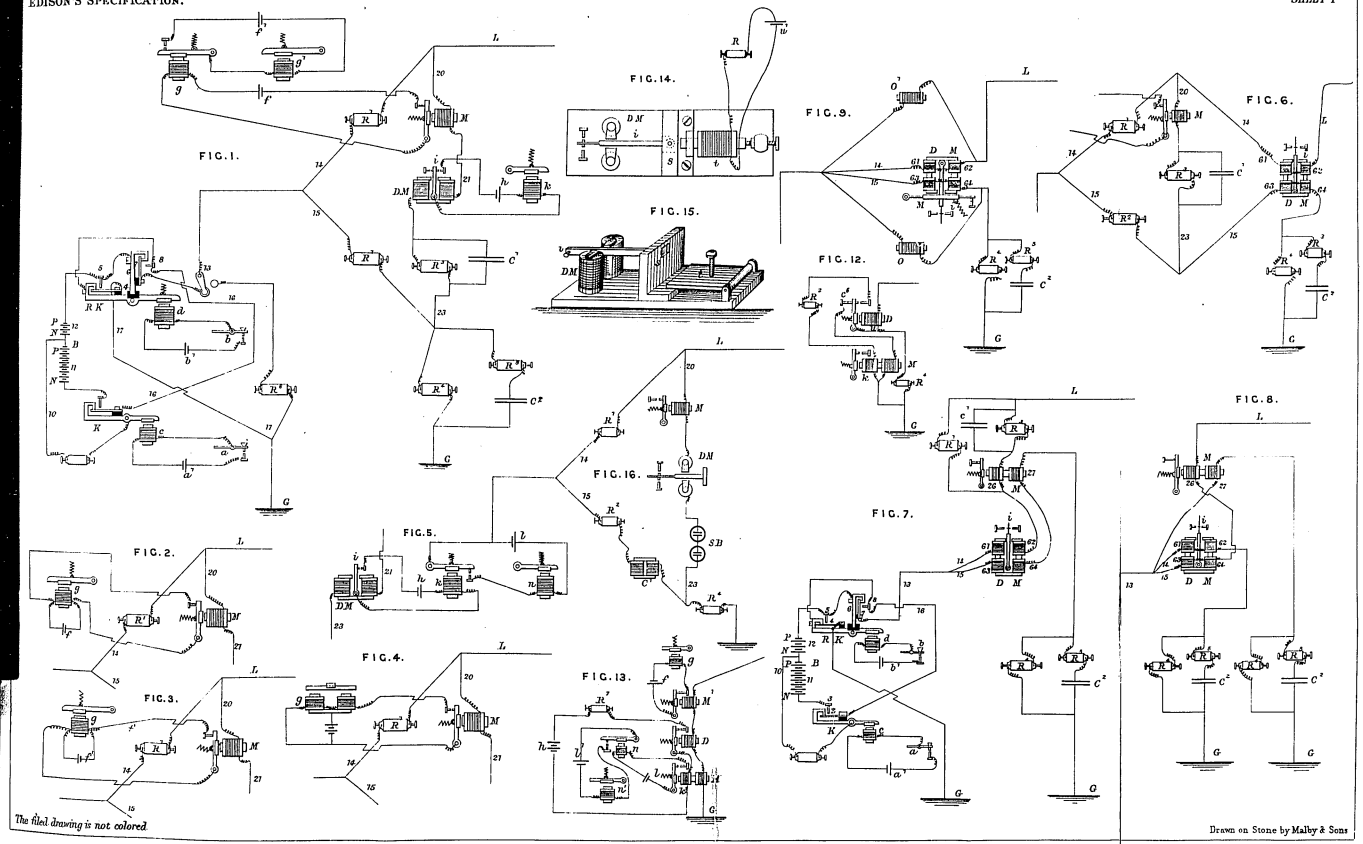

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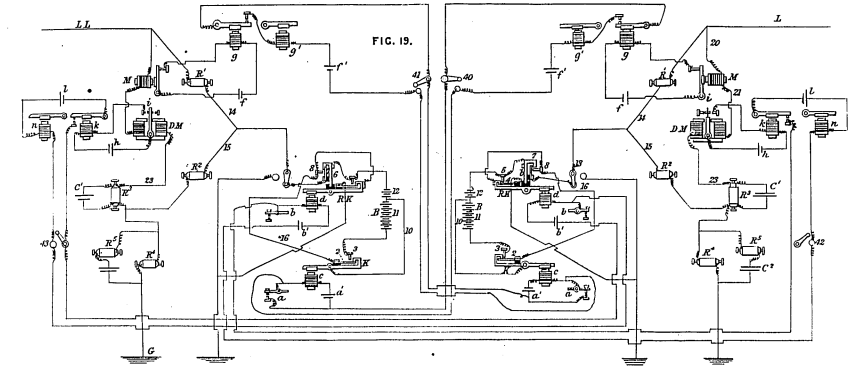
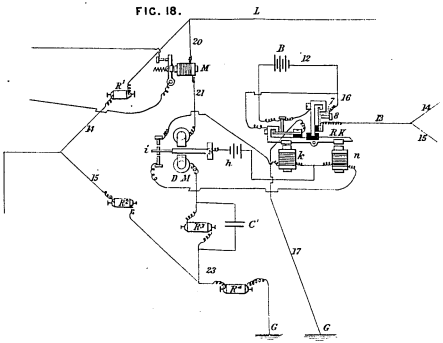
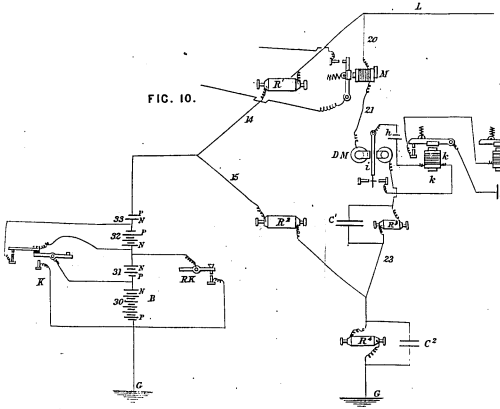
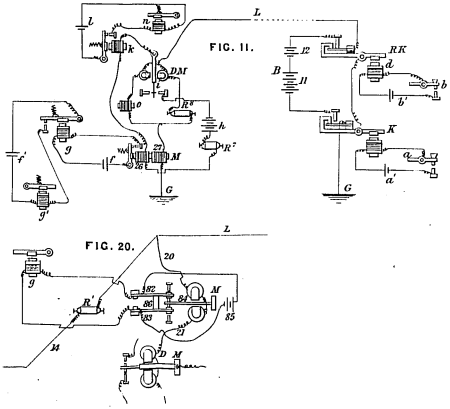
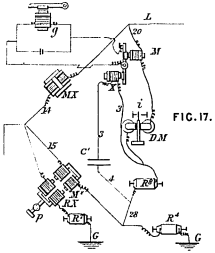
SHEET 2











The filed drawing is not colored.

Drawn on Stone by Malby & Sons.

LONDON Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE
Printers to the Queen's most Excellent Majesty 1875

[Second Edition.]

A.D. 1875, 29th October. N° 3762.

Autographic Printing.

LETTERS PATENT to Thomas Alva Edison, of Newark, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN AUTOGRAPHIC PRINTING."

Sealed the 26th April 1876, and dated the 26th October 1875.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 29th October 1875.

THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America. "IMPROVEMENTS IN AUTOGRAPHIC PRINTING."

The object of this Invention is to print from a sheet of paper or other material that is perforated with numerous holes in lines forming the letters, numbers, designs, or other configurations to be duplicated by printing.

The perforations passing through the paper are filled with ink, preferably an ink containing glycerine and analine colors. The ink is rubbed into the perforations by a roller, brush, or other yielding device, and then the perforated and inked paper is laid upon the sheet to be printed, and pressure is applied sufficient to cause the ink in the holes to pass upon the surface of the paper and produce a duplicate of the perforations; this may be done by the pressure of a roller that also serves to fill the holes with ink for the next impression, so that by this means a large number of duplicate manuscripts can be produced, and there is but little more work in preparing the original than in writing on paper.

The mode of preparing the original sheet is similar to that of preparing any written, or lettered, or drawn document or design.

The writer or draughtsman holds a pen, but instead of ink there is a needle or point that vibrates with very great rapidity within a small tube or stylus, and projects each stroke enough to pass through the paper into some soft substance, such as cloth or blotting paper. The speed of vibration of the needle is to be such

[Price 6d.]

as to make the perforations very close together, even with rapid movement of the pen. For this purpose I prefer to use a small magnet upon the top of the stylus, actuated by a battery with flexible conductors, and the armature opens and closes the circuit. A variety of electrical or mechanical devices may be employed to give this rapid vibration to the needle.

I remark that it is preferable to have the needle vertical, and provide a handle at an inclination to the stylus, so that the handle may be held like a pen.

In cases where the letters are made by a type writing machine with keys that are depressed to compose the words, the type are to be composed of numerous needle points arranged in the form of letters, so that the printing therefrom perforates the paper as aforesaid.

The battery that I prefer to use is provided with carbon poles in porous cups containing terchromate of potash and sulphuric acid, and the carbon and zinc poles are upon arms that are elevated or depressed upon a standard; this furnishes a battery especially adapted to the rapid movements of the electro-magnet.

The edges of the perforated sheet are preferably held by a frame while the ink is being pressed through the perforations to the sheet below.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 27th April 1876.

THOMAS ALVA EDISON, of Newark, in the State of New Jersey, United States of America. "IMPROVEMENTS IN AUTOGRAPHIC PRINTING."

The object of this Invention is to print from a sheet of paper or other material that is perforated with numerous holes in lines forming the letters, numbers, designs, or other configurations to be duplicated by the printing.

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The mode of preparing the original sheet is similar to that of preparing any written, or lettered, or drawn document or design.

The writer or draughtsman holds a pen, but instead of ink there is a needle or point that reciprocates with very great rapidity within a small tube or stylus, and projects each stroke far enough to pass through the paper into some soft substance, such as cloth or blotting paper. The speed of reciprocation of the needle is to be such as to make the perforations very close together, even with a rapid movement of the pen. For this purpose I prefer to use a small magnet upon the top of the stylus, actuated by a battery with flexible conductors, and the armature opens and closes the circuit. A variety of electrical or mechanical devices may be employed to give this rapid reciprocation to the needle.

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The edges of the perforated sheet are preferably held by a frame while the ink is being pressed through the perforations to the sheet below.

In the Drawings,—

Fig. 1 is a vertical section of the pen or stylus in a form that I have discovered to be very convenient in use.

Fig. 2 is a side view of the actuating magnet.

Fig. 3 is a section of the press as closed.

Fig. 4 is a plan of the same as open.

Fig. 5 is a section of the paper holding clamp.

Fig. 6 is a section of the pen-holding stand in smaller size than the pen, Fig. 1.

Fig. 7 is a plan of the battery, illustrating also the flexible connection to the distant pen as in use.

Fig. 8 is an elevation of the battery partially in section; and

Fig. 9 is a section of the pole-supporting catch of the battery.

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The pen which I make use of consists of a tube *a* tapering to a small point *b*, and a needle *c* within the tube, which needle is reciprocated with great rapidity, and when the needle point *c* is projected it is sufficiently long to reach through the paper, upon which the tube of the pen rests, and when retracted the needle is drawn within the tube, so that the small end thereof is free to be moved from place to place. The great rapidity in the movement of the needle point produces the punctures in the paper sufficiently close together to form lines when the pen is manipulated in writing or drawing, and as nothing is removed from the paper its strength is not materially injured by the punctures or perforations.

It will be apparent that any suitable device may be employed for reciprocating the perforating needle, several of which are hereafter described, but I prefer to use an electro-magnet and revolving armature fly wheel for this purpose.

The electro-magnet *d* is upon the frame *e* that supports the axis 2 of the fly wheel *f*, and this fly-wheel is connected with the armature *g*. Upon the axis 2 there is an eccentric or a cam with one or more arms acting upon the stock 3 at the upper end of the needle bar. It is preferable to employ a three-pointed cam d^2, as seen in Fig. 10, upon the axis 2, so as to give three up-and-down motions to the needle point each revolution of the axis 2. The commutator or circuit closer to the electro-magnet is composed of the spring *l*, acted upon by the notched or flattened disc 4 to open and close the circuit through the screw 5, and thus actuate the electro-magnetic motor in the usual manner.

The wires 6 and 7 lead to the battery, shown in Figs. 7 and 8, in which the glass cells *m* are in a metal stand *n* held by the standard *o* and ring o^1. The carbon pole *p* and zinc pole *q* are connected with the cover *r* and cross-bar r^1, that are fitted to be raised or lowered upon the standard *o*, and when raised out of use, as in Fig. 8, the parts are held up by the latch *s* passing into a notch in the standard *o*, as in Figs. 8 and 9. The porous cups s^1 in the cells *m* are nearly half graphite pen, because it occupies but little space and is easily transported and brought into or put out of action.

The liquids preferably employed in the battery are terchromate of potash and sulphuric acid.

The tube of the pen screws into the frame *e*, and is provided with a set nut 9, by means of which it can be clamped after the tube has been adjusted, so as to allow the needle to be drawn into the tube and projected by the motor, as aforesaid.

A stand l^1, Fig. 6, is provided with a hole at the upper end, of a size to receive the tube pen, and support the same, and protect the point from injury when entered within such stand.

The conductor from the pen to the battery must be flexible, so as to allow the pen to be easily moved about in performing the writing; and the paper to be punctured should be placed upon some soft substance, such as cloth or blotting paper, to prevent injury to the needle-point in writing.

The mode of printing from the perforated sheet is to fill the holes with ink by means of a roller applied to the right side of the perforated sheet, and then when said ink is well worked into the holes to place beneath such perforated sheet the paper upon which the impression is to be made, and then pass over the perforated sheet a roller that presses the ink through the perforations to the surface of the sheet below.

As a convenient means for doing this printing I make use of the bed *t*, to which the frame *u* is hinged at 12, and at the corners of this frame *u* are the spring plates 13 with holding points, and these spring plates are raised from the surface of the frame by turning the cam buttons 14, so that the perforated sheet can be placed between the frame and these clamping springs, and then the cam-buttons 14 being turned the other way allows the springs to catch and firmly hold the corners of the perforated sheet. A sheet of paper is now laid down upon the bed *t*, the frame *u* is turned over upon it, and secured by the clamping-button 16 being

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turned over the edge of the frame *u*; a roller covered with felt or similar material and having ink upon its surface is now rolled over the perforated sheet until all the holes are filled and an impression made by the ink through such holes upon the surface of the sheet below.

The hinged frame holding the perforated sheet may be lifted for inspecting the impression, and closed down again if the impression is defective at any point.

After the holes are filled the impression upon other sheets can be made in succession very rapidly, and a small quantity of ink is added from time to time.

Printers' ink thinned out with castor oil may be employed. Aniline or colors may be used mixed with glycerine or molasses.

It is generally preferable to have the perforating needle perpendicular to the paper, and for convenience in holding the same there may be a handle c^1 connected with the pen tube *a*, and occupying an inclined position, as shown in Fig. 11.

The same object is accomplished by the device shown in Fig. 12. The perforating needle instead of being at the end of the rod *c* is at the end of a short rod *c'* that is guided in the short tapering tube *b*, and said rod c^1 is connected to the rod *c* by the lever a^2. This arrangement allows of the tube *a* being held in the same position that a pen is usually held, and of maintaining the perforated needle perpendicular to the paper.

Various forms of electro-magnetic and other motors may be employed to revolve the shaft that reciprocates the perforating needle, and I will now briefly describe a few of the motors that may be advantageously employed.

In Fig. 13 the helices d, d^1, are sustained in the frame *e*, and the shaft 2 passes freely through them and forms their core. Upon the shaft 2 arms *f*, f^1, placed at right angles to each other, and upon the frame *e* in line with said arms are metallic blocks 18, 18, forming stationary armatures. After the shaft 2 is once set in motion the circuit is opened and closed to the helices d, d^1, at the proper times by a disk and contact spring similar to those before described, and the magnetic action causes the arms *f*, f^1, to be alternately moved around towards their respective blocks to keep up a continuous rotation of the shaft.

In Fig. 14 the needle-rod *c* is connected to the vibrating armature lever e^1, and this lever is moved first in one direction by the magnet d, and then in the other by a rectractile spring, and when the armature lever and needle-rod are drawn down by the spring the circuit changer is moved and closes the circuit to the magnet d, and the armature lever is moved upward, and in so doing moves the circuit changer in the other direction and breaks the circuit, and so on, the circuit is opened and closed, and thus a very rapid reciprocating movement is given to the needle rod *c*.

In Fig. 15 the electro-magnet d is firmly secured to the shaft 2, and the armature *f* is stationary. There are insulated hubs or commutators upon the shaft 2, and the wire connections from the helices d to the commutators and contact springs are arranged in the usual manner, so that the current is sent first through one helix and then the other, and a rotary motion obtained by the cores of the magnet being alternately drawn toward the armature *f*. By this device the magnet acts as a fly-wheel, and its weight is utilized.

In Fig. 16 the needle-rod *c* is connected to a vibrating armature lever e^1 moved by the magnet d and spring, as in Fig. 14; but a secondary magnet d^3 not upon the pen, but in metallic connection with the magnet d, is employed to open and close the circuit to said magnet d by actuating the armature lever d^4 and circuit changer d^5.

The device shown in Fig. 17 may be employed with equal advantage for opening and closing to the circuit to the magnet d. In said Fig. 17 the electro-magnet d^3 is stationary, and gives motion to a revolving armature and commutator, and this latter in connection with the contact spring d^6 opens and closes the circuit from the battery to said magnet d^3, and at the same time to the magnet d, the wire connections being arranged as shown.

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In Fig. 18 the needle-rod c is connected a rocking lever c^1 that is provided with two armatures, and by means of the circuit charger c^2 operated by said rocking armature lever, and the wire connections represented, the circuit is opened and closed to one helix and then to the other of the magnet d, and a rapid reciprocation given to the needle rod c by the lever c^1.

In Fig. 19 the needle rod c is actuated by a revolving shaft and a cam operating in the stock of the needle rod c, as before described; but the shaft is made in two pieces f^1, f^2, so that one part may slide within the other as the pen tube a is moved over the paper, and one or more ball joints are provided in the shaft f^1, f^2, to allow for still greater freedom in writing. The power to rotate the shaft f^1, f^2, is communicated from a foot treadle by the link f^3 to a pulley f^4, and from the latter a belt leads to a small pulley on the shaft f^1, f^2, mounted in bearings upon the table on which the operator writes.

In Fig. 20 a small turbine water wheel is made use of to revolve the shaft 2; this wheel is secured to said shaft, and is within the case h^2, and the water is admitted to the wheel from the vessel h^4 through the flexible tube h^3 and is discharged by the tube h^5 to the vessel h^6. Water may be taken from time to time from the vessel h^6 to replenish the supply in the vessel h^4.

In Fig. 21 rotation is given to the shaft 2 by the operator turning the handle upon the arm i^4 back and forth with the left hand while holding the pen tube a in the right hand in the usual manner. There is a ratchet wheel i^2 upon the shaft 2 and a pawl i^3 upon the arm i^4, and as said arm is moved back and forth as aforesaid, the pawl turns the ratchet wheel i^2 and shaft 2, and the fly wheel i^1 serves to keep the motion regular.

In Fig. 22 rotation is given to the shaft 2 by means of the wheel m^4 which is connected to the pen tube a by the hinged arm m^3, and said wheel rolls upon the table as the pen tube is moved over the paper. Upon the side of the wheel m^4 is a large pulley m^3, and from it a belt leads to a small pulley m^2, and by the bevel gearing the motion is finally transferred to the shaft 2. The wheel m^4 should be sufficiently broad and heavy to stand upright and not be liable to tip over.

In Fig. 23 the needle rod c is connected to a thin metallic plate that forms the armature to the electro-magnet d, and when the circuit is closed and the plate attracted by the magnet, the plate moves the circuit changer d^2 and breaks the circuit; the spring of the plate immediately raises it from the magnet and closes the circuit, and the plate and needle-rod are again brought down, and so on, the circuit is opened and closed and a very rapid movement given to the needle-rod.

Fig. 24 illustrates how letters or characters like ordinary types may be punctured in the paper. A lever o^3 for each letter or character is employed, as in type-writing machines, and the letter or character at the end of each lever is formed of a number of needle points properly positioned and secured. The levers o^3 are connected to finger keys o^5, and I have shown the paper to be punctured as passing under a roller o^2; when a finger key is depressed and a letter punctured, the parts assume the position shown by dotted lines in said Fig. 24. Any desired mechanism may be employed for feeding the paper.

The letters or characters formed of needle points might be upon a wheel, as represented in Fig. 25. I have shown this wheel n^4 as upon a lever n^5 and fitted so as to be turned by hand to bring the desired letter or character of needle points into position for puncturing the paper, and the paper is punctured by depressing the lever n^5 which carries with it the wheel n^4. A spring returns the lever to its normal position against the stop n^3, and a pawl n^2 taking teeth upon the side of the wheel n^4 may be employed for holding said wheel in the position to which it is turned. The paper to be punctured is supported upon a bed beneath the wheel n^4, and it may be moved by hand or automatically.

What I claim as my invention and desire to secure by Letters Patent is,—

First. The tube a with a tapering end in combination with a puncturing needle and mechanism for reciprocating the same, substantially as set forth.

Edison's Improvements in Autographic Printing.

Second. The portable perforating instrument for writing or drawing composed of a tube or stock with a small and similar to a pen, and a perforating needle, and means for reciprocating such needle rapidly, substantially as set forth.

Third. The method herein specified of printing in permanent semi-fluid ink by puncturing a sheet of paper or similar material with numerous small holes, filling such holes with a semi-liquid ink and pressing the same upon the surface to be printed, substantially as set forth.

Fourth. The swinging frame u and paper holding clamps 13 in combination with the bed t for receiving and holding the sheet of perforated paper, and the sheet to be printed, substantially as set forth.

Fifth. The combination with the revolving magnetic motor, pen holder a, and puncturing needle c of the cam Z^2, having three or more points, substantially as set forth.

Sixth. The combination with the portable hand perforating instrument having an electro-magnetic motor of a flexible conductor and a battery, substantially as set forth.

Seventh. The portable galvanic battery composed of cells in a stand with a pole supporting rod, latch, and cross head, in combination with flexible conductors, a magnetic motor, and a perforating pen, substantially as set forth.

Eighth. The ink herein specified for autographic printing composed of printers' ink thinned out with castor oil, as set forth.

Ninth. The pen tube a provided with the handle a^1 in combination with the perforating needle and electro or other motor for actuating the same, as set forth.

Tenth. The needle c^1 guided in the short tube b^1 and connected to the rod c by the lever a^2 in combination with the tube a and motor for actuating the needle, substantially as and for the purposes specified.

Eleventh. The letters or characters for a type-writing machine made of needle points for puncturing paper or other material for printing, as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Third day of April, A.D. 1876.

THOMAS ALVA EDISON. (L.S.)

Witnesses,

CHAS. H. SMITH, 121, Nassau St., New York, N.Y.

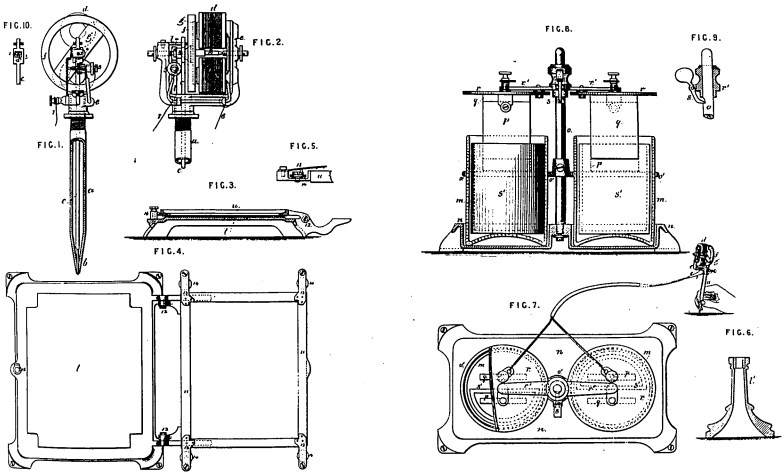
GEO. T. PINCKNEY " " " " "

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

[19638.—50.—3/80.]

D.1875, Oct.29. No. 3762.
ISON'S SPECIFICATION.
(2nd Edition.)

(2 SHEETS)
SHEET 1.



Malby & Sons, Photo-Lith.

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

FIG. 11.

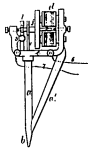


FIG. 12.

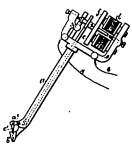


FIG. 13.

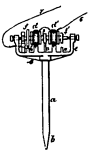


FIG. 14.

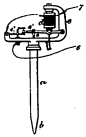


FIG. 15.

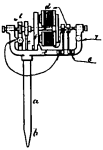


FIG. 16.

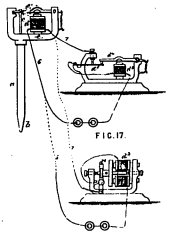


FIG. 17.

FIG. 18.

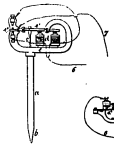


FIG. 19.

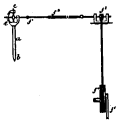


FIG. 20.

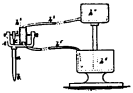


FIG. 21.

FIG. 22.

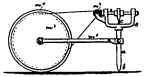


FIG. 23.

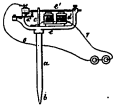


FIG. 24.

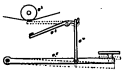
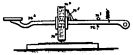


FIG. 25.



Malby & Sons, Photo-Litho.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

A.D. 1876, *26th July.* Nº 3012.

Acoustic Telegraphs.

(This Invention received Provisional Protection only.)

PROVISIONAL SPECIFICATION left by Thomas Alva Edison at the Office of the Commissioners of Patents on the 26th July 1876.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN ACOUSTIC TELEGRAPHS."

It is well known that if two bars or forks of steel of equal length, breadth, and thickness be secured at one end and properly adjusted they will vibrate at the same rate of speed. Reeds of this kind have been used in telegraphs.

I have availed of this well-known operation to construct a peculiar telegraph that is capable of being used either singly, one instrument at each end, or two or more instruments at each end of different tones or pitch, so that the instrument at one end energises the instrument at the other end of corresponding pitch.

The Invention consists of two acoustic reeds, tuning forks, or other bodies following the law of the pendulum, operated directly by electro-magnetism or indirectly by the intervention of sonorous bodies or columns of air between such reeds, tuning forks, or other bodies following the law of the pendulum and the electro-magnet; such electro-magnetic acoustical reeds are placed at the two ends of a telegraphic circuit, and being provided with contact breaker points, switches, connections, and other proper devices, vibrate when properly adjusted in perfect or practically perfect unison with each other.

The Invention further consists in combining with such acoustical instrument of other contact devices besides those that are necessary to operate the reeds themselves, which contact devices serve to throw the wire upon which the electro-magnets operating such reeds are placed upon a new set of electro-magnets entirely disconnected from the reed magnets at both ends of the wire simultaneously at that particular period of time when the wire is not transmitting an acoustical wave. The second set of electro-magnets contained in a branch circuit at both ends may be common Morse relays operating sounders and controlled by a key, the two receiving the same number of waves as the reed but not at the same time, and concurring with great rapidity act upon the relay in the same manner as a constant current.

The Invention further consists in peculiar contact points to ensure a perfect transfer of the wave from the signalling instruments to the reed instruments, and *vice versâ*.

[*Price 4d.*]

Edison's Improvements in Acoustic Telegraphs.

The Invention further consists in peculiar forms of reeds and electro-magnets operating the same to suit the various conditions which arise upon long, short, and inferior telegraphic circuits.

The Invention further consists in the method of compensating for the mutilation of the acoustical and signalling waves by the static current, and by derived currents from contiguous wires.

The Invention further consists in the method of transferring the main wire from the acoustic magnets and circuit at terminals and at way stations to the signalling magnets at the same station.

The Invention further consists in the method of transferring the signals from one circuit into another.

The Invention further consists in the method of transferring the signals into branch wires.

The Invention further consists in the method of duplexing and quadruplexing the signalling circuit obtained by acoustical transfer.

The Invention further consists in the method of transmitting two messages in the same direction upon the circuit obtained by acoustical transfer.

The Invention further consists in the method of signalling (upon the circuit obtained by acoustical transfer) by the use of polarized relays and reversed currents.

The Invention further consists in the method of transferring several separate circuits from into two branches, each by means of local reeds operated by contact points upon the main line reed.

The Invention further consists in transferring a single circuit to several branches simultaneously at both ends of the wire, so as to allow the transmission of several distinct messages in either direction at the same time.

The Invention further consists in the method of regulating telegraphic machinery so as to run synchronously at both ends of the line in connection with the transmission of telegrams over the same wire at the same time.

The Invention further consists in the method of transmitting messages upon the acoustic transfer branch as well as the other branch by a reversal of the current.

The Invention further consists in placing upon one telegraphic wire acoustical relay instruments which serve to work the local acoustical instruments upon another and distinct wire, the latter of which is divided by such local reed into a great number of signalling circuits.

In carrying out the means for accomplishing these objects I avail of the tuned reeds or forks of bell metal, steel, or other metal as the means for producing synchronous vibrations, and employ electro-magnets for keeping such reeds or forks in continuous vibration, such electro-magnets being placed in a telegraphic circuit and contact devices upon the reeds serving to open and close the circuit of such telegraphic line, thereby keeping both fork or reeds vibrating in the same time. These reeds or forks are provided with extra contact devices for opening and closing a local circuit, in which are placed one or more electrically actuated forks either making the same number of vibrations as the main line forks or the multiple of the same, and these local forks move synchronously at both ends of the line. Connected to these forks are contact points and springs arranged with several split circuits in which are placed signalling instruments. The connections being the same at both ends of the line, and these forks and their contact points and springs at each terminal is connected together by another telegraphic line. The synchronously moving local reeds serving to transfer such telegraph line from one set of signalling instruments at each end to several other sets of instruments one after the other with great rapidity, but in such a manner that the main line is never upon more than two sets of signalling instruments at the same time, hence several messages may be transmitted over the one wire practically at the same time. There may be included within the same local circuit another set of acoustical transfer forks which may serve to transfer another telegraph line alternately to several sets of signalling instruments simultaneously at both ends of the line.

Edison's Improvements in Acoustic Telegraphs.

Each one of the branches or splits so obtained and upon which signalling takes place may be arranged with a Wheatstone bridge, equating resistance condenser, or electro-magnet, the last two for balancing the static charge of the line so as to allow of the transmission of two messages in opposite directions at the same time upon each split; with this arrangement I make use of circuit preserving keys. In practice I prefer to use polarized receiving relay circuit preserving and reversing finger keys for signalling.

LONDON: Printed by George Edward Eyre and William Spottiswoode, Printers to the Queen's most Excellent Majesty. 1877.

[Third Edition.]

A.D. 1877, 30th JULY. N° 2909.

Controlling by Sound the Transmission of Electric Currents, and the Reproduction of Corresponding Sounds at a Distance.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS, AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 30th July 1877.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN INSTRUMENTS FOR CONTROLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS, AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE."

The vibrations of the atmosphere, which result from the human voice or from any musical instrument or otherwise, are made to act in increasing or lessening the electric force upon a line by opening or closing the circuit, or increasing or lessening the intimacy of contact between conducting surfaces placed in the circuit at the receiving station; the electric action in one or more electro magnets causes a vibration in a tympan, or other instrument similar to a drum, and produces a sound, but this sound is greatly augmented by mechanical action. I have discovered that the friction of a point or surface that is in contact with a properly prepared and slowly moving surface, is very much increased or lessened by the strength of the electric wave passing at such point of contact, and from this variation in the friction a greater or less vibration is given to the mechanism or means that produce or develope the sound at the receiving station, thereby rendering clear and distinct the sound received that otherwise would not be audible.

To carry out the peculiarities of my Invention under the varying conditions of use, I have devised several modifications of the transmitting, receiving, and intensifying devices employed in this sound telegraph; portions of the apparatus

[Price 8d.]

are interchangeably, available in transmitting or recording; others are adapted to local use; some are only available in transmitting, and others are only for receiving; and some portions of my improvement can be availed of to make a record of the atmospheric sound waves, or of the electric waves, or pulsations corresponding thereto or resulting therefrom.

In one form of my apparatus the sound passes into a resonant box having one, two, or more tympans at its sides that are vibrated thereby, the tension of these being various, so as to respond to different sound waves, and the electric connections pass through all to one line or circuit, in which is a battery and the distant receiving instrument. Circuit contact points are provided at one or both surfaces of the tympan or tympans; the tympans are of parchment, foil, mica, sheet metal, or similar material. I find platinum, foil, or mica to respond advantageously when the waves from the mouth are made to pass through a slot resembling the larynx placed within the resonant tube. The contact points or surfaces are sometimes metallic, but plumbago, or similar semi-conducting material, into which the tympan or diaphragm is brought more or less intimately into contact, or a point or pin thereon serves to lessen or increase the electricity passing at that point.

In the receiving portion of the instrument the tympan is acted upon directly by an electro magnet, or through an armature, or the tympan is provided with an arm extending out over a slowly moving surface or cylinder, and the electric current, passing at the point of contact, increases or lessens the friction, and produces the vibration of the arm and tympan in proportion to the difference of friction developed between the arm and moving surface by the passage and cessation of the current through the chemically prepared paper, preferably moistened with a salt of mercury and an alkali.

This feature is capable of very extended development in telegraphy; the clearness and extent of sound produced by the receiving tympan exceeds anything heretofore attained in acoustic telegraphs.

The frictional surface may be any material which absorbs liquids, such as chalk or paper; the transmitting points in all instances should be a poor conductor of electricity, such as cyanide of copper, peroxide of lead, or plumbago, which substance may be moulded with non-conductors.

Where plumbago is used between the cores and armature of an electro magnet, and such plumbago is included in a local or relay circuit, the pulsations or rise and fall of electric tension will correspond to that in the coils of the electro magnet in consequence of the varying compressing action on the plumbago or similar material, which increases and decreases its resistance.

A polarized arm, near a soft iron plate upon the tympan, will receive a motion from the vibration of the tympan, and make more or less intimate contact with the plumbago point without arresting the motion of such tympan.

In the line the effect of the static charges and discharges are neutralized by condensers or by helices in shunts. Where a rapidly revolving wheel is contiguous to the transmitting tympan, and there is a plate of platina on that tympan to which the circuit is connected, the rise and fall of electric tension will result accurately from the movement of the tympan, producing greater or less contact with the wheel; a spring may intervene between the wheel and tympan.

A spring or reed, attached to a stud at one end, and to the tympan at the other, is vibrated or undulated by the sound waves acting on the tympan, and produces greater or less contact with pieces of tin foil surrounding it, which also are in the electric circuit or plumbago; contact points near the side of such spring effect the same object. A column formed of disks of tin foil in a glass tube, pressed upon by the vibrations of the tympan, also are employed under some circumstances to regulate the electric tension in the circuit.

The moving surface, whose friction is increased or decreased upon the passage and cessation of the current aforesaid, is employed in some instances to vibrate by the electric and mechanical action a frame of strings of different pitch to produce musical sounds, or to give motion to reeds or resonant boxes.

The transmitting tympan is sometimes made of cloth, with plumbago pressed into its surfaces, and generally it is preferable to weight the centre of the tympan, and take the motion a little one side of the centre to prevent a false movement or rebound. These sound transmitting and receiving instruments are applied in single or multiplex telegraphs; the connections through the Wheatstone bridge, or the induction coils, being used in the well known ways, and the circuits being either single or relays.

Where alluminium is introduced in the electric circuit in connection with a material containing an electrolite, the vibration of the tympan, and an extension from it to the material containing the electrolyte, causes a depolarization at the point of contact at every vibration, thus increasing and decreasing the strength of the current by depolarization.

Where a slot is made in the diaphragm, and the airways impinge against the same, the vibration of the hissing sounds is augmented.

The resonant chamber for convenience is made portable, so as to be presented to the mouth.

In addition to the tympan for transmitting the vowel sounds, I employ another opening in the speaking tube or chamber, which opening may be increased or lessened; I stretch edgewise over this a thin reed of foil, which is set in vibration by all hissing consonants, and make contact with a plumbago point, or with a platina point, which is connected to the line through an adjustable resistance coil, or a self-acting reed giving a hiss may be thrown in and out of circuit by the movement of the foil reed.

For transmitting and receiving letter by letter, I employ a shaft with 30 wheels, and contact springs resting upon them; the wheels are provided with teeth of such number and character that they will cause the springs to be vibrated against a plumbago point the necessary number of times, and with proper pressure to transmit the letter, which is rendered audible at the distant station by the magnet or frictional surface. Each wheel is controlled by a key of a key board.

Q 3223. Wt. 10607.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 30th January 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS, AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE."

This Invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and the same sound is produced at the receiving station, so that oral communications can be sent by electricity and clearly distinguished at the receiving station. Musical tones may also be sent, but my present Invention is especially available in transmitting and receiving oral communications. In transmitting musical tones, the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent, but in speaking there is little change in the musical tone, but considerable in the modulations and inflections of the voice. In my present Invention I make use of the vibrations given to a diaphragm or tympan, by speaking into a resonant case, to produce a rise and fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound waves produced by articulation, and the electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate.

The instruments in a complete form are represented in Figs. 1 and 2, Fig. 1 being a section of the transmitting instrument, and Fig. 2 of the receiving instrument.

The resonant tube or box *a* is of a size and shape adapted to being spoken into, against which the sound waves from the human voice act, and these and the motion that the diaphragm receives is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery B connected to the line *l* will transmit a greater or less current to the distant electro-magnet *m*, Fig. 2, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate *c*, and develop sound corresponding to the articulation at the transmitting station.

The general features thus described pervade my entire Invention, but in developing the same many useful and important modifications and variations have been made, which I will proceed to set forth.

For convenience the speaking instrument, Fig. 1, is provided with a handle a^1, and flexible conductors to the battery and line respectively, so that it may be handled and brought to the mouth; and in like manner it is preferable to place the hearing instrument, Fig. 2, in a movable handle b^1, so that it can be placed with the plate *c* against the ear; this brings the sound close to the organs of hearing, and the resonant plate touching the ear increases the distinctness of the sound, and prevents any false or prolonged vibrations of the plate.

In some of the modifications I have shown the speaking instrument as a fixture, and also the hearing instrument as a fixed resonant tube, these being variable to suit the persons or the places.

The first especial feature that requires separate consideration is the peculiarity of the resonant tube for the voice. I have experienced great difficulty in reproducing the sound of the hissing consonants, such as *s*; this appears to arise from the fact that this sound is deflected downwardly in leaving the mouth, and does not act distinctly upon the diaphragm. By providing an edge in the resonant tube below the mouth, upon which such consonant sounds are received, the vibrations

are given either to the resonant tube or deflected to the diaphragm. I find it preferable to employ a hole *e* at the lower part of the mouth piece, against the edges of which the downward sound waves are directed. The same effect will be produced by a vibrating edge placed in the lower part of the mouth piece, or the opening into the resonant box may be contracted to about half an inch in diameter to effect the same purpose. The next feature requiring consideration is the character of the diaphragm in the speaking instrument.

Many materials have been employed by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of these produce a prolonged or secondary vibration from their own resonant character, hence the articulation is defective, and the sound vibrations blend. After extensive experiments I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when secured at its edges responds with the greatest accuracy to the sound vibrations, and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diaphragm or tympan.

I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts, or disks of semi-conducting elastic fiber, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator; it is more or less compressed, according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed or lessens as the fiber expands.

This fiber is placed in a small roll *t*, between the delicate diaphragm spring *u*, Fig. 9, and the variable presser *v*, adjustable by screw or otherwise in the electric circuit at this point, or it may be within a cavity in said presser *v*, as in Fig. 1, there being a delicate cork center piece *w* to the diaphragm *b*, with a piece of platina foil *x* in contact with the fiber; in all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina or similar material extending to the center from the line or battery connection.

The fiber is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, the conducting power varying with the density of the tuft or bunch of fiber. The delicate spring *u*, Fig. 9, upon the mica diaphragm *b* is easily secured by solder passing into fine holes bored in the mica.

In Fig. 3 the tension regulator is made by water or other semi-conducting electrolytic fluid in a cup *f*. The wires to the battery are led to the electrodes or conducting points 2, 3, in such cup that are opposite to points 4, 5, upon the diaphragm *b*.

The cup is adjustable to vary the distance between the electrodes and the rise and fall of tension results from the varying distance between the electrodes as moved by the vibrations of the diaphragm. If there are several electrodes opposite to each other and insulated, except at their ends, and the circuit led from one to the other so that the current passes through all the electrodes in succession, the rise and fall of electric tension will be promoted, because the smallest vibration of one set of electrodes is multiplied by the number of places at which the metallic circuit is interrupted or varied. In the receiving or hearing instrument the resonant plate *c* should be of tinned iron, resting upon the edges of the case, and the magnet *m*, adjustable nearer to or further from the same, and connected loosely by slotted tongues. This plate will respond to the electric pulsations by the attraction of the magnetized cores, and the sound resulting will be audible when the plate is placed near or against the ear. If the plate is pressed away from the magnet by a delicate

spring or allowed to fall away from the magnet, the instrument may be used as a call by using a key or switch at the sending station to open and close the circuit, and thus move the plate to give a loud sound. In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact such as would result from a disk covered with plumbago placed adjacent to a diaphragm, also covered with plumbago or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit. I also sometimes employ a shunt circuit in the line, or a branch circuit to the earth, in which is placed an electro-magnet to neutralize any static charge or discharge in the line. I sometimes perforate the diaphragm 10, Fig. 18, and place a strip of elastic material, 40, across said diaphragm over the hole, and upon this a piece of foil, so that the same responds to very weak vibrations, and in some instances two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters, or tensions, so as to respond to varying sounds or acoustic condition, the various tension regulators being all in the electric circuit; this will produce greater rise and fall of tension for longer lines in consequence of the diaphragms acting simultaneously on the tension regulators. In some instances it is preferable to make the mouth piece of the speaking instrument sufficiently large or flaring to receive all the sound vibrations, whether coming from the mouth, nose, or throat.

Several contact points of platina, placed contiguous to the diaphragm, may be used, the same acting to increase or lessen the surface contact, according to the amplitude of vibration of the diaphragm, and a drop of liquid such as oil or glycerine, between the contact point and diaphragm, will serve to maintain a closed circuit, but the movement of the diaphragm produces rise and fall of tension. The tension regulator, formed of fiber and conducting or semi-conducting material, may be either dry or moistened with a liquid.

In some instances I make use of the best quality of lamp black retained within a case to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm.

I am enabled to record to record the sounds produced by the human voice or otherwise by causing the movements of the diaphragm to be registered on paper or soft sheet metal, and then the paper may be used in an instrument to reproduce the sound upon a delicate diaphragm by giving to the same a vibration similar to that originally given by the voice. *h*, Fig. 4, is the indenting transmitter, the diaphragm having a knife-edge point. *i* is the paper which has previously been passed through a machine to raise a V shaped rib 6. The movement of the diaphragm of *h*, when the drum is in motion, causes the knife edge point *l*' to indent the raised rib to varying depths, according to the amplitude of vibration of the diaphragm, thus these indentations represent accurately all the tones and varying inflections of the human voice. The paper after being indented is passed through a second apparatus *n*, Fig. 5, almost similar to *h*. A spring 9 has a knife-edge which rest upon the raised indented rib 6, the spring being connected to a delicate diaphragm 10 by a string or straw. The indented rib reproduces in the spring 9 the movement of the indenting point, and either by direct action, or through the vibration of a string, conveys the same motion to the diaphragm of *n*, and reproduces previous sounds.

If these sounds are to be transmitted over a telegraph line the diaphragm 10, see Fig. 6, is provided with a cork disk *w*, and fibrous tension regulator *t*, before described, to produce the rise and fall of electric tension on the line. The sound may be recorded in ink as represented in Fig. 7. The diaphragm of *h* operates a very flexible self-feeding pen *o*, and causes the continuous line to be wide or narrow, according to the amplitude of vibration of the diaphragm. The ink used should dry quickly, and the strip may be passed at any time thereafter through the instrument shown in Fig. 8, beneath the arm 12, having a point or points resting on the

paper; this arm is connected with a resonant diaphragm, and the ink marks produce more or less friction, according to the breadth and amount of ink deposited, and this will set the diaphragm of a vibrating, and reproduce the vibrations of the diaphragm of *h*. An obvious modification would be to coat the paper with a substance which would cause considerable friction, or even rough unsized paper might be used, and a spring provided with a burnished point, rather flat, would cause the surface of the paper to be made smooth more or less, according to the vibration of the diaphragm, and the differences in the surface of the paper would produce a response in the receiving diaphragm.

I sometimes arrange the battery in connection with the transmitting instrument, as shown in Fig. 10. *h* is the resonant chamber at the end of which is the diaphragm 10, and at each side of this diaphragm there are springs c^2, c^3, having points made of compressed plumbago mixed preferably with gum rubber, but any substance not liable to rapid decomposition, or the elastic or fibrous tension regulator aforesaid may be used. These points face each other on opposite sides of the diaphragm, and make contact with platina foil disks secured to the diaphragm. The spring c^2 passes through a hole or small slot in the side of the chamber *h*, d^2, d^3, are the main batteries. The battery d^2 has zinc to the line or spring c^2, and the battery d^3 has copper to the line or spring c^3. When the springs c^2 and c^3 are adjusted to make contact with the diaphragm equally, no current passes to the line; but when the diaphragm is vibrated, its movement to one side, say c^2, causes a greater pressure upon the plumbago on that spring, and a lessening of the pressure on the plumbago on c^3; hence the balance of the batteries c^2 and c^3 will be destroyed, c^2, having the advantage, will send a negative current to line; upon the return of the diaphragm the battery currents will again neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery d^3 will send a positive current to the line. As the tension regulator of fiber or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. In Fig. 11 is shown the contact spring, which may be used adjacent to the diaphragm at one or both sides thereof. c^2 is a U shaped spring secured to the screw c^4, which is adjusted back and forth by the thumb nut c^5; c^6 is the pillar holding such screw; *r* is a piece of soft rubber, or equivalent substance, placed between the prongs of the spring c^2; c^7 is a wire or band which serves to bind the prongs tightly against the rubber *r*, so as to prevent the prongs acting as a tuning fork, and transmitting harmonic vibrations not desirable; r^2 is the plumbago contact point. The object of the U spring and rubber is to present a semi-rigid point for contact, so as to prevent a rebound, and allow of a slight yield when the plumbago is pressed by the diaphragm.

In Fig. 3 the diaphragm of the receiving instrument is vibrated by a strip of paper chemically prepared that is in motion, the pulsations of electricity passing over the line and producing more or less friction between the paper and an arm upon the diaphragm. The resonant box or chamber *n* is provided with a diaphragm as aforesaid, and to said diaphragm an arm h^2 is connected; at its outer end is an adjusting screw h^3, that presses upon a platina-faced spring h^4 that is secured to this arm, and said spring rests upon the strip of paper that passes over the drum h^5. The paper is moved slowly by rotating the drum h^5, and the waves of electricity coming over the line pass through the arm h^2 to the platina-faced spring h^4, thence through the paper to the earth. If a negative current passes in the opposite direction, nearly all friction between the platina plate and the paper ceases, and the diaphragm of the resonant box *n* regains its normal position. When the positive current passes through the same channel, the normal friction of the paper is augmented, and the chemical surface acting upon the platina spring arm serves to give a forward movement to the diaphragm of the resonant box. Thus the mechanical force applied to move the chemical paper or surface acts with the electric current to produce the vibration of the diaphragm of the resonant chamber, and

these vibrations will correspond to those of the diaphragm *b*, made by speaking in the tube *a*. The principle of this method of obtaining motion by electro-chemical decomposition is, that when a moving surface is in contact with a slightly yielding substance, the tendency is to move the latter by and with the former. If the circumstances of contact are varied, the adhesion of the surfaces will be sufficient to cause the moving surface to move the yielding substance, or else to cause the yielding surface to slip more freely, and by its spring go in the opposite direction to the moving surface. The passage of electricity at the surfaces in contact will change the frictional adhesion, making it more or less, according to the substances employed.

By balancing the mechanical forces, so that when the surfaces in contact are not electrified, the moving surface carries with it the yielding surface; and, when electrified, the yielding surface slips back over the moving surface, a mechanical movement is obtained that is dependent on the electrical condition of the surfaces in contact.

When it is requisite to obtain very perfect articulation, and when loudness is not essential, I adopt a modification, shown in Fig. 12, of the device for compressing and expanding the infl. of conducting fiber, which modification consists in placing between the diaphragm 10 and the fiber *t* a vibrating tongue 21 of steel, permanently magnetized, and arranging it to act in the same manner upon the tension regulator *t* as if it was the diaphragm. I replace the cork upon the diaphragm by a thin armature of iron 22 which is in close proximity to the magnetized tongue, which tongue is secured at one end like an acoustic reed. In this position the diaphragm is free to move, and at its approach to and recession from the magnetized tongue causes said tongue to follow its movements by magnetic attraction, and thus the tongue is made to perform what the diaphragm previously performed in varying the tension of the electricity on the line.

A modification of the magnetic receiving instrument consists in an iron plate fitted into the aperture of a resonant tube, and secured by a central support, leaving its outer circumference free to vibrate when the metal is attracted by the poles of the electro-magnet, which are of course on each side of its center; but it is preferable to place the support slightly out of center, as some portions of the plate will then be in tone for every sound. A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice; the circuit with this plate is completed through one or more tension regulators placed around its edges. I have discovered that vulcanite or hard rubber produces cold and heat waves on its surface by the slightest movement, and in some cases I employ the same for the diaphragm of the resonant case *h*, Fig. 13, and place a thermo-electric pile *k*[2] in very close proximity to the rubber, so that the vibration of the diaphragm 10 producing changes of temperature will cause currents of electricity to be set up within the thermo-battery, and these passing over the line *l* and acting upon a very delicate electro-magnet and diaphragm will reproduce the sounds acting upon the rubber diaphragm.

In practice I combine with the speaking or telephonic apparatus signal bells, so arranged that when the telephone is not in use the line is thrown upon the bell by a switch, which also acts as a call on the bell. One feature about the bells is that preferably German silver wire in the helix, and thus serve to prevent a rapid consumption of battery power.

A large number of telephonic wires may be worked from one battery if these bells are used. The method I adopt for coating non-conducting substance with metallic substance is the reduction to the metallic state of metals from their salts by exposing them to the fumes which arise from the moist phosphide of a metal, such as phosphide metallic electrodes, and volatilizing the electrodes by the passage of electric sparks; such volatilized metals settle upon and coat the silk.

When great loudness is desirable, as in factories, the tympan of the receiving

instrument may be made to control an air valve of a reservoir in which air is stored under a regulated pressure. The air allowed to escape will act with great power upon a local diaphragm. This diaphragm, to obtain clear sounds, requires a damper to check prolonged vibrations. It must be dampened by holding the fingers against it, or by a tightly stretched cord rubbing against it, or by a screw provided with a rubber tip held against it. For repeating from one circuit into another I use with the receiving diaphragm the elastic tension regulator Fig. 1 in addition to the electro-magnet, and connect the relay or second circuit through the same, so that waves received from the distant station cause the magnet to vibrate the diaphragm, and this acting upon the tension regulator transmits the waves into the second circuit, and they are received at the other end by an electro-magnet and diaphragm. In some instances I make a record of the sound by the movements of the diaphragm, using for that purpose a strip of paper moved along regularly between two rollers, 25, 26, as in Figs. 14 and 15; and there is a smooth thread or fine wire of soft metal 30 between the paper and the upper roller 25, and moving along with it. The diaphragm 10 of the resonant box is connected by a delicate rod 28 with this thread or wire as near to the bight of the roller as possible, there being a fork or eye through which the thread passes, hence deflections or bends are made in the thread or wire just before it is imbedded into the paper by the pressure of the rollers; this may be used to reproduce the sound by vibrating a resonant diaphragm by the undulations of the groove made by the thread or cord.

By placing the fibrous tension regulator within a small band of india-rubber the same is rendered more elastic, and the fiber is allowed to expand by the heat of the current without altering the electric tension. In cases where a strip of hard rubber or a cord of silk or other material coated with plumbago or metallic foil is introduced between the diaphragm and a rigid support, the expansion and contraction due to the passage of the electric currents will produce a movement upon the diaphragm corresponding to the diaphragm producing the electric pulsations. In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this, by placing upon the diaphragm or tympan 10, Fig. 17, a small cylinder *l*[1] of hard rubber or non-conducting material within which is the fibrous tension regulator *t* resting upon a piece of platina foil connected to one pole of the battery, and within this cylinder *l*[1] is a disk *l*[2] of iron or other metal, loose, but pressed towards the tension regulator by a spring *l*[3] and screw cap *l*[4], and the other electric conductor is connected with said spring. The inertia of the metal disk causes more or less compression of the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk *l*[2] to a yielding spring *l*[11] that extends across from one edge of the diaphragm to the other, as seen in Fig. 16. This construction of tension regulating device is especially available with large diaphragms. In some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm, so as to check or dampen any prolonged or false vibration, and render the sound more clear and free from prolonged tones. In preparing the tension regulator I find in some cases that it is preferable to use lampblack mixed with pure plumbago, amorphous phosphorous, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate.

In Fig 19 I have represented the circuit as passing through the diaphragm 10, tension regulator *t*, and a Dulucs dry pile battery D, P, B, to the earth. This battery is composed of about 300 pairs of paper disks coated with silver and black oxyd of manganese. Fig. 20 illustrates the device before mentioned for intensifying the sound; 10 is the diaphragm vibrated by the sound; 42 is a valve moved by such diaphragm; 43 is a reservoir containing air under a given pressure; *b* is the diaphragm against which the air, allowed to escape by the valve, acts, and *t* is the tension regulator to transmit the electric pulsations, or a hearing resonant case may be applied at the same place.

Many curious and useful features have been developed by my extended researches in the transmission and reproduction of sound. Among these may be mentioned the fact that a copper diaphragm, or a diaphragm of mica or other flexible material containing copper, will act with the core of a polarized electro-magnet in transmitting or receiving. If a diaphragm with a metallic button upon it is so close to the core of a permanent magnet, see Fig. 21, that the vibrations of the diaphragm by sound cause such button to strike the core a corresponding electric pulsation will be set up in a helix around the magnet, and the same will act in an electro-magnet at the distant instrument by molecular disturbance.

If the diaphragm 10 has a thin tube attached to the center, as seen in Fig. 22, and this project into the helix around one pole of magnet 48, the current set up in that helix by the vibration of the diaphragm and tube will be much greater than that resulting from a flat armature on the diaphragm or the diaphragm itself. The magnet 48 may be polarized by a helix and a local circuit and battery. If one pole of the permanent magnet m^5, Fig. 23, is connected with the plate c so that the latter is polarized by induction, the current set up in the helix around one pole of the said magnet is intensified. In this case I groove the end of the helix-pole, and insert a small piece of soft rubber or tubing that serves to dampen the vibrations of the diaphragm, and prevent false or harmonic vibrations in speaking. Fig. 24 represents the diaphragm 10, tension regulator t with its adjusting screw and local circuit containing the battery B, passing through a primary induction coil 49, and there is a key 50 in the same circuit. A secondary induction coil 51 is in the line circuit, and is influenced electrically by the change of tension in the local circuit by the vibrations of the diaphragm 10. The secondary coil is sometimes required with many layers of fine wire to set up a current of high tension to overcome the inductive effect from the line wires, being adjacent to each other. I place the receiving instrument at the distant station between the induction coil and the earth as at K, and use an electro-magnet E, M, with polarized armature to strike a bell; this will respond when the key 50 in the local circuit at the distant station is opened and closed. In Fig. 25 a similar induction coil 49 and local circuit is represented, but the tension regulator is made of platina foil upon the surface of two soft rubber tubes, one on the diaphragm, the other on the adjusting screw. A shunt and rheostat at R^1 serves to prolong the magnetism in the induction coil, and thus ensure a gradual rise and fall of electric tension in the line instead of a cessation of the same when the platina surfaces separate, and at the receiving diaphragm c, the rise and fall of electric tension in the line and its helix acts upon the permanent magnet to produce the vibrations of the diaphragm c, and by connecting a shunt around the helix, and placing therein the secondary battery S, B, composed of metallic plates in acidulated water, the action is rendered more uniform and the sound distinct. When the diaphragm is arranged as in Fig. 26 to act upon a spring 56, through an intervening piece of soft rubber, said spring 56 produces rise and fall of electric tension by employing a range of resistances 57 with spring tongues adjacent to 56. The greater amplitude of vibration of the diaphragm the more direct will be the electric circuit connections and the less resistance, because the circuit will pass along the spring instead of going through all the resistance coils. When there is an electrophorous or resinous disk 58, immediately facing each diaphragm 10, as in Fig. 27, and the line connections are made to the diaphragm, and the earth connections are made to these electrophorous disks 58, the diaphragms will respond each other, the wire used for the acoustic or speaking telegraph is influenced by 50 to each other in either speaking or hearing. Where several line wires run near each other, the wire used for the acoustic or speaking telegraph is influenced by 50 induction, and false sounds will be produced. I counteract this tendency by placing one or more electro-magnets 59, Fig. 28, in the circuit of the speaking telegraph, and one or more electro-magnets 60 in the circuit of the adjacent wires, and bringing the opposite cores of 60 at such a distance from the cores of 59 that a certain magnetic action will be set up in 59, by induction in the opposite direction to the induction currents from the adjacent line or lines. By adjusting the distance between these magnets when the speaking telegraph is not in use, until there is not any sound at the diaphragm from the induction currents, then

these currents will be neutralized, whether strong or weak, and will not produce any false sounds when the speaking telegraph is in use. I also employ double coils of wire for the same purpose, one coil being in the acoustic wire, and the other in the wire to be compensated.

A convenient form for the sound recorder or phonograph is to employ a cylinder 61, see Fig. 29, having a helical groove in its surface covered with tin foil, and the cylinder is revolved regularly by clock-work and moved endwise by a screw on its shaft, so that the indenting point D from the diaphragm 10 of h will be always in line with such groove, hence the vibrations of the diaphragm will be recorded by indenting the foil into the groove, and hence the same sound will be reproduced by the point E of the hearing instrument n, giving to the diaphragm of n the motions that result from the indentations of the foil moving in contact with such point. The foil may be on a flat grooved plate and be indented and act as before named.

I claim as my Invention,—

First. In an instrument for transmitting electric impulses by sound, a diaphragm or tympan of mica, substantially as set forth.

Second. In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of an electric tension regulator for varying the resistance in a closed circuit, substantially as set forth.

Third. The combination in an electric instrument actuated by sound, of a diaphragm or tympan, a conductor, and an electric tension regulator composed of yielding material and electric conducting material.

Fourth. The combination with the diaphragm and electric conductor, of the cork disk and tension regulator, substantially as set forth.

Fifth. In a telegraph operated by sound, the transmission and reproduction of the human voice by increasing and decreasing the resistance of the circuit, substantially as set forth.

Sixth. The combination with a diaphragm or tympan, of electrolytic fluid and electrodes, the latter being vibrated by the diaphragm and varying the resistance in the electric circuit, substantially as set forth.

Seventh. In an instrument for transmitting sounds by electricity, a resonant case having an opening or edge, against which the consonant sounds act, substantially as set forth.

Eighth. In combination with the diaphragm or tympan and the electric tension regulator, the adjusting screw or variable presser to regulate the resistance of the tension regulator in the electric circuit, substantially as set forth.

Ninth. The combination with a diaphragm in a speaking telegraph instrument of a moving surface, and a recording mechanism actuated by the diaphragm or tympan, substantially as set forth.

Tenth. The combination with a receiving diaphragm or tympan in a telegraph operated by sound, of a moving surface, a point, and a connection from the same to the diaphragm, substantially as set forth.

Eleventh. The combination in an instrument for receiving sounds electrically, of an electro-magnet and armature plate, substantially as set forth.

Twelfth. The combination in the telegraphic circuit of two or more tympans, a resonant box, and one or more circuit closers to each tympan, substantially as set forth.

Thirteenth. The combination with the diaphragm of a resonant case, of circuit connections at both sides of the diaphragm and a battery, substantially as shown in Fig. 10.

Fourteenth. In a telegraph instrument operated by sound, a resonant box or case, a diaphragm and flexible circuit connections, substantially as set forth, whereby the instrument is made portable and can be placed to the mouth in speaking.

Fifteenth. In a telegraphic instrument operated by sound, an electro-magnet and resonant plate or diaphragm provided with a handle and flexible conductors, substantially as set forth.

Edison's Impts. in Controlling by Sound the Transmission of Electric Currents, &c.

Sixteenth. The receiving instrument consisting of an electro-magnet, a case, and a loose metallic plate, arranged and operated substantially as set forth, to act as a call or to receive the message.

Seventeenth. In a telegraphic apparatus operated by sound, one or more contact points of yielding material that produce a rise and fall of tension proportioned to the pressure exerted by the diaphragm, substantially as set forth.

Eighteenth. In a telegraphic apparatus operated by sound, a receiving instrument provided with a resonant surface, in combination with a frictional surface moved by power and acting in connection with the electric current to vibrate such resonant receiver, and produce tones corresponding to those at the transmitting apparatus, substantially as set forth.

Nineteenth. The combination with a thermo-electric pile of a vulcanite or hard rubber diaphragm, substantially as set forth.

Twentieth. The method herein specified of recording the undulations of the diaphragm or yielding material, and the reproduction of sound by such material acting upon a diaphragm to communicate to the same vibrations similar to the original ones, substantially as set forth.

Twenty first. The combination with the diaphragm and tension regulator of a magnetized tongue and an iron plate upon the diaphragm, as set forth and shown in Fig. 12.

Twenty second. In combination with the diaphragm operated by sound, an electro-magnet, a valve, and a chamber of compressed air or gases to reproduce the sounds in louder tones.

Twenty third. The method herein specified of preparing fiber for electric tension regulators by conducting or semi-conducting material associated intimately with such fiber, substantially as set forth.

Twenty fourth. In an instrument for receiving sound telegraphically, a plate, loose at its edges, and supported upon a post or standard, substantially as set forth.

Twenty fifth. The combination with the sending and receiving diaphragm of the dry pile illustrated in Fig. 19.

Twenty sixth. The combination in a telephonic instrument, of an iron diaphragm and a magnet, one end of which is attached to the magnet, substantially as specified.

Twenty seventh. The combination with the electric circuit and a diaphragm of an induction coil and magnet, substantially as set forth.

Twenty eighth. The combination with the induction coil, diaphragm, and local circuit of a key in said circuit, and a call or sounder at the distant station, substantially as set forth.

Twenty ninth. The combination with a diaphragm of rheostats or resistances in the line or local circuit, and means for short circuiting such resistances in proportion to the movement of the diaphragm, substantially as set forth.

Thirtieth. In combination with an electric circuit containing instruments for reproducing sound, one or more electro-magnets and one or more compensating magnets for neutralizing the inductive effect of adjacent telegraph wires, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Twenty fourth day of December, A.D. 1877.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 76, Chambers St., New York.
WILLIAM G. MOTT, " " "

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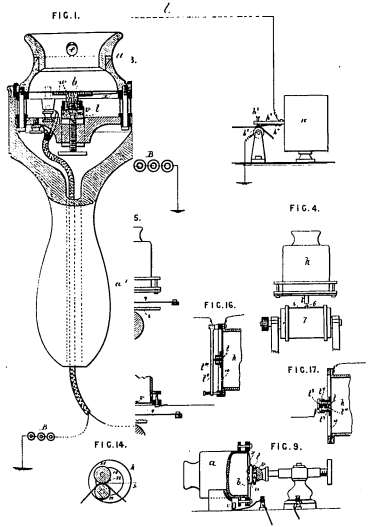
For Her Majesty's Stationery Office.

[10607.—200.—10/80.]



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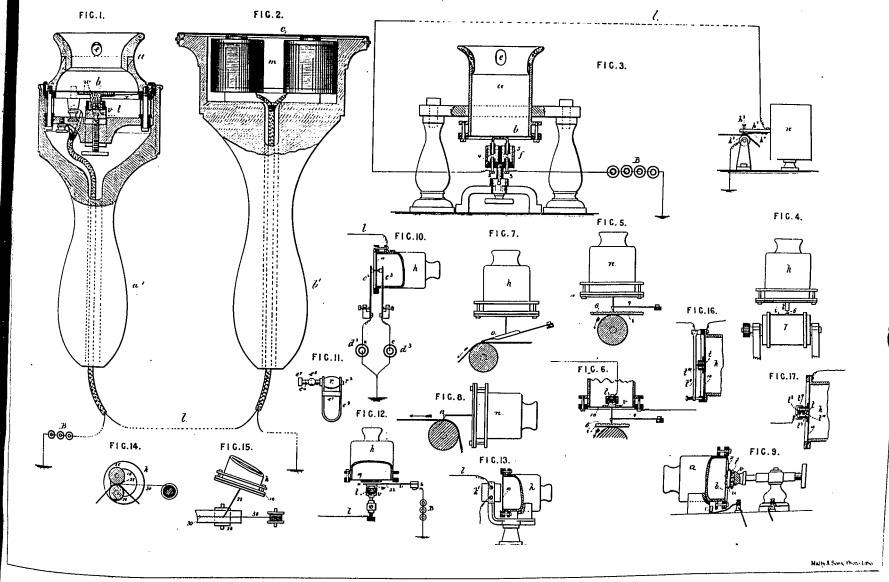

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(2 SHEETS)
SHEET 2

FIG. 18.

FIG. 19.

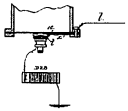


FIG. 20.

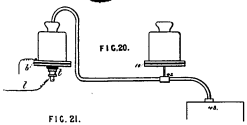


FIG. 21.

FIG. 22.

FIG. 23.

FIG. 24.

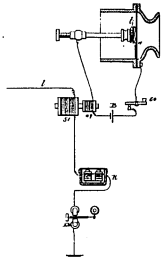


FIG. 25.

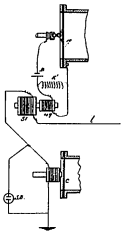


FIG. 26.

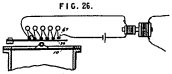


FIG. 27.

FIG. 28.

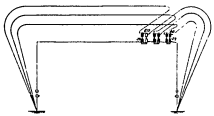
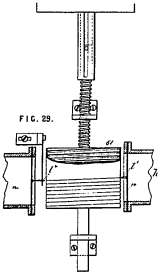


FIG. 29.



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A.D. 1877 . . . . . Nº 2909*.

Controlling by Sound the Transmission of Electric Currents and the Reproduction of Corresponding Sounds at a Distance.

THE EDISON TELEPHONE COMPANY'S DISCLAIMER AND MEMORANDUM OF ALTERATION.

[EDISON'S PATENT.]

Filed 10th February 1880.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, the Edison Telephone Company of London, Limited, of 11, Queen Victoria Street, in the City of London, send greeting:—

WHEREAS Her Most Excellent Majesty, Queen Victoria, by Her Royal Letters Patent, under the Great Seal of Great Britain and Ireland, bearing date at Westminster, the Thirtieth day of July, in the Year of Our Lord, One thousand eight hundred and seventy seven, in the Forty-first year of Her Reign, did for Herself, Her heirs and successors, give and grant unto Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, his executors, administrators, or assigns, or such others as he his executors, administrators, or assigns should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention of "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE," for and during the term of Fourteen years thence next ensuing: And whereas in pursuance and performance of a proviso in the said Letters Patent contained the said Thomas Alva Edison did within Six calendar months next after the date of the said Letters Patent cause a Specification in writing under his hand and seal purporting to particularly describe the nature of the said Invention, and in what manner the same was to be performed, to be duly filed in the Great Seal Patent Office: And whereas by Indenture bearing date the Second day of August, One thousand eight hundred and seventy nine, and made between the said Thomas Alva Edison of the one part, and as the Edison Telephone Company of London, Limited, of the other part, the said Thomas Alva Edison assigned unto us the said Edison Telephone Company of London, Limited (*inter alia*), the said herein before recited Letters Patent, and all rights, powers, authorities, privileges, advantages,

[*Price* 6*d.*]

profits, emoluments, and benefits to the said Letters Patent, appertaining or belonging: And whereas since the date of the said Assignment we have been advised and have ascertained that the said Specification contains matters which are of doubtful novelty, or which are not of sufficient practical value and utility to justify their retention; and we are therefore desirous of striking out the whole of the claiming clauses contained in the said Specification, with the exception of the first, second, eighteenth and twentieth claiming clauses, and of striking out parts of the description contained in the body of the said Specification; and also of otherwise altering the said Specification, and correcting certain clerical errors contained in the said Specification in manner more fully hereafter appearing.

NOW KNOW YE, that we the said Edison Telephone Company of London Limited, by and with the leave of Her Majesty's Attorney General, and for the reasons aforesaid do alter the said Specification, by striking out of the said Specification printed by the Queen's Printers, and published at the Great Seal Patent Office in One thousand eight hundred and seventy nine, the words "the same" which occur on page 4, at the end of line nine, and the beginning of line 10 respectively, and substituting therefor the words "a corresponding"; we also strike out the word "the" which occurs between the words "and" and "electro" on the said page, line twenty two, and substitute therefor the word "an"; we also insert between the words "the" and "instruments" which occur on the said page line twenty five the word "transmitting" and we strike out the letter "s" at the end of the said word "instruments"; we also strike out the word "are" which occurs on the same line and substitute therefor the word "is"; We also insert between the words "in" and "Figs." (an abbreviation of the word Figures) which occur on the same line, the words "section in" and we strike out the letter "s" in the said word "Figs"; we also strike out the words commencing with "and" on the said line twenty five and ending with the first word "instrument" on line 26 of the said page four we also strike out the words "of the" which occur between the Figure "2" and the word "receiving" on the said line twenty six and substitute therefor the words "represents a"; we also add after the word "instrument" at the end of the said line twenty six the words "which may be employed with it"; we also strike out the word "the" at the commencement of line twenty seven on the said page four and substitute therefor the words "referring to Figure 1 the"; we also strike out that portion of the Specification commencing with the words "in Fig" on page 5, line forty one, and ending with the word "sound" on page 6, 35 line three; we also strike out that portion of the Specification commencing with the words "I also" at the end of line eight and ending with the words "the line" on line eleven of the said page 6; we also strike out the whole of lines twenty four to twenty eight inclusive on the said page 6; we also strike out the words "to record" which are repeated on line thirty five of the said page 6 and add the letter "s" to the word "rest" which occurs on line forty seven of the said page 6. We also strike out of page 8, lines thirty seven to forty two inclusive, and lines forty six to fifty three inclusive. We also strike out of page 9 lines eighteen to twenty three inclusive, and lines thirty seven to forty one inclusive. We also strike out of page 10 lines seventeen to thirty seven inclusive. We also strike out 45 of page 11 lines ten to thirteen inclusive, and lines forty four to fifty seven inclusive, and we add at the end of line thirty seven of the said page eleven after the word "named" the words following:—"I would observe in conclusion that I do not claim generally the transmission and reproduction of sounds by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying

We also strike out the word "an," which occurs between the words "of" and "electric" on line 47 of the said page 11, and we add the letter "s" to the word "regulator," which occurs on the same line 48, to make it read "regulators," and we also strike out "regulators" without the words "substantially as hereinbefore described."

Drawings, except as hereinafter mentioned, but

We also strike out of page 12 lines one to thirty inclusive, lines thirty six and thirty seven, and lines forty two to fifty six inclusive. We also strike out the word "eighteenth" which occurs at the commencement of line thirty one on the said page 12, and substitute therefor 55

the word "third." We also strike out the word twentieth which occurs at the commencement of line thirty eight of the said page 12, and substitute therefor the word "fourth." We also strike out the word "or" which occurs on line thirty nine of the said page 12, and substitute therefor the word "on." We also strike out of page 13 lines one to fourteen inclusive. And in order that the effect of the said Disclaimer may be clearly understood we annex hereunto a copy of the said Specification as it will appear when so amended, the preamble and testing clause being omitted.

This Invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and a corresponding sound is produced at the receiving station so that oral communications can be sent by electricity and clearly distinguished at the receiving station.

Musical tones may also be sent, but my present Invention is especially available in transmitting and receiving oral communications.

In transmitting musical tones the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent, but in speaking there is little change in the musical tone but considerable in the modulations and inflections of the voice.

In my present Invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound waves produced by articulation, and an electro magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate.

The transmitting instrument in a complete form is represented in section in Fig. 1, and Fig. 2 represents a receiving instrument which may be employed with it.

Referring to Fig. 1, the resonant tube or box *a* is of a size and shape adapted to being spoken into the same, having an opening at one end or side and a diaphragm or diaphragms *b*, against which the sound waves from the human voice act, and these and the motion that the diaphragm receives is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery B connected to the line *l* will transmit a greater or less current to the distant electro magnet *m*, Fig. 2, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate *c* and develop sound corresponding to the articulation at the transmitting station.

The general features thus described pervade my entire Invention, but in developing the same many useful and important modifications and variations have been made, which I will proceed to set forth.

For convenience the speaking instrument Fig. 1 is provided with a handle a^1 and flexible conductors to the battery and line respectively, so that it may be handled and brought to the mouth, and in like manner it is preferable to place the hearing instrument Fig. 2 in a movable handle b^1, so that it can be placed with the plate *c* against the ear; this brings the sound close to the organs of hearing, and the resonant plate touching the ear increases the distinctness of the sound and prevents any false or prolonged vibrations of the plate.

In some of the modifications I have shown the speaking instrument as a fixture, and also the hearing instrument as a fixed resonant tube, these being variable to suit the persons or the places.

The first especial feature that requires separate consideration is the peculiarity of the resonant tube for the voice. I have experienced great difficulty in reproducing the sound of the hissing consonants, such as *s*; this appears to arise from the fact that this sound is deflected downwardly in leaving the mouth, and does not act distinctly upon the diaphragm. By providing an edge in the resonant tube below the mouth upon which such consonant sounds are received the vibrations are given

either to the resonant tube or deflected to the diaphragm. I find it preferable to employ a hole *e* at the lower part of the mouth piece against the edges of which the downward sound waves are directed. The same effect will be produced by a vibrating edge placed in the lower part of the mouth piece, or the opening into the resonant box may be contracted to about half an inch in diameter to effect the same purpose. The next feature requiring consideration is the character of the diaphragm in the speaking instrument.

Many materials have been employed by me such as metals, horn, vellum, celluloid, ivory, &c., but almost all of these produce a prolonged or secondary vibration from their own resonant character, hence the articulation is defective and the sound vibrations blend.

After extensive experiments I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when secured at its edges responds with the greatest accuracy to the sound vibrations and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diaphragm or tympan.

I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice, the circuit to the line must be always closed and the transmission be produced by a rise and fall of electric tension resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts or disks of semi-conducting elastic fiber, such as particles of silk and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator, it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed or lessens as the fiber expands. This fiber is placed in a small roll *t* between the delicate diaphragm spring *u*, Fig. 9, and the variable presser *v* adjustable by screw or otherwise in the electric circuit at this point, or it may be within a cavity in said presser *v*, as in Fig. 1, there being a delicate cork center piece *w* to the diaphragm *b*, with a piece of platina foil *x* in contact with the fiber; in all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina or similar material, extending to the center from the line or battery connection.

The fiber is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, the conducting power varying with the density of the tuft or bunch of fiber.

The delicate spring *u*, Fig. 9, upon the mica diaphragm *b* is easily secured by solder passing into fine holes bored in the mica.

In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact such as would result from a disk covered with plumbago placed adjacent to a diaphragm also covered with plumbago or other semi-conducting material so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit. I sometimes perforate the diaphragm 10, Fig. 18, and place a strip of elastic material 40 across said diaphragm over the hole, and upon this a piece of foil, so that the same responds to very weak vibrations, and in some instances two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters, or tensions so as to respond to varying sounds or acoustic condition, the various tension regulators being all in the electric circuit, this will produce greater rise and fall of tension for longer lines in consequence of the diaphragms acting simultaneously on the tension regulators. In some instances it is preferable to make the mouth-piece of the speaking instrument sufficiently large or flaring to receive all the sound vibrations, whether coming from the mouth, nose, or throat. The

tension regulator formed of fiber and conducting or semi-conducting material may be either dry or moistened with a liquid.

In some instances I make use of the best quality of lamp black retained within a case to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm. I am enabled to record the sounds produced by the human voice, or otherwise by causing the movements of the diaphragm to be registered on paper or soft sheet metal, and then the paper may be used in an instrument to reproduce the sound upon a delicate diaphragm by giving to the same a vibration similar to that originally given by the voice.

h, Fig. 7, is the indenting transmitter, the diaphragm having a knife-edge point; *i* is the paper which has previously been passed through a machine to raise a V shaped rib *6*. The movement of the diaphragm of *h* when the drum is in motion causes the knife-edge point *P* to indent the raised rib to varying depths according to the amplitude of vibration of the diaphragm, thus these indentations represent accurately all the tones and varying inflections of the human voice. The paper, after being indented, is passed through a second apparatus *n*, Fig. 5, almost similar to *h*. A spring 9 has a knife edge which rests upon the raised indented rib 6, the spring being connected to a delicate diaphragm 10 by a string or straw.

The indented rib reproduces in the spring 9 the movement of the indenting point, and either by direct action or through the vibration of a string conveys the same motion to the diaphragm of *n*, and reproduces previous sounds. If these sounds are to be transmitted over a telegraph line the diaphragm 10, see Fig 6, is provided with a cork disk *w* and fibrous tension regulator *t* before described, to produce the rise and fall of electric tension on the line. The sound may be recorded in ink, as represented in Fig. 7. The diaphragm of *h* operates a very flexible self feeding pen *o*, and causes the continuous line to be wide or narrow according to the amplitude of vibration of the diaphragm. The ink used should dry quickly and the strips may be passed at any time thereafter through the instrument shown in Fig. 8 beneath the arm 12 having a point or points resting on the paper, this arm is connected with a resonant diaphragm, and the ink marks produce more or less friction according to the breadth and amount of ink deposited, and this will set the diaphragm of *n* vibrating and reproduce the vibrations of the diaphragm of *h*.

An obvious modification would be to coat the paper with a substance which would cause considerable friction, or even rough unsized paper might be used and a spring provided with a burnished point rather flat would cause the surface of the paper to be made smooth more or less according to the vibration of the diaphragm, and the differences in the surface of the paper would produce a response in the receiving diaphragm.

I sometimes arrange the battery in connection with the transmitting instrument, as shown in Fig. 10.

h is the resonant chamber at the end of which is the diaphragm 10, and at each side of this diaphragm there are springs c^3, c^3, having points made of compressed plumbago mixed preferably with gum rubber, but any substance not liable to rapid decomposition or the elastic or fibrous tension regulator aforesaid may be used. These points face each other on opposite sides of the diaphragm, and make contact with platina foil disks secured to the diaphragm.

The spring c^3 passes through a hole or small slot in the side of the chamber *h*; c^3, c^3, are the main batteries. The battery d^2 has zinc to the line or spring c^3, and the battery d^3 has copper to the line or spring c^3. When the springs c^3 and c^3 are adjusted to make contact with the diaphragm equally no current passes to the line, but when the diaphragm is vibrated its movement to one side, say c^3, causes a greater pressure upon the plumbago on that spring, and a lessening of the pressure on the plumbago on c^3, hence the balance of the batteries d^2 and d^3 will be destroyed, d^2 having the advantage will send a negative current to line upon the return of the diaphragm, the battery currents will again

neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery d^3 will send a positive current to the line.

As the tension regulator of fiber or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. In Fig. 11 is shown the contact spring, which may be used adjacent to the diaphragm at one or both sides thereof. e^2 is a U shaped spring secured to the screw e^1, which is adjusted back and forth by the thumb nut e^2; e^3 is the pillar holding such screw; r is a piece of soft rubber or equivalent substance placed between the prongs of the spring e^2; e^4 is a wire or band which serves to bind the prongs tightly against the rubber r so as to prevent the prongs acting as a tuning fork and transmitting harmonic vibrations not desirable; r^2 is the plumbago contact point. The object of the U spring and rubber is to present a semi-rigid point for contact so as to prevent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm. In Fig. 3 the diaphragm of the receiving instrument is vibrated by a strip of paper chemically prepared that is in motion, the pulsations of electricity passing over the line and producing more or less friction between the paper and an arm upon the diaphragm.

The resonant box or chamber n is provided with a diaphragm as aforesaid, and to said diaphragm an arm h^2 is connected. At its outer end is an adjusting screw h^3 that presses upon a platina faced spring h^4 that is secured to this arm, and said spring rests upon the strip of paper that passes over the drum h^5.

The paper is moved slowly by rotating the drum h^5, and the waves of electricity coming over the line pass through the arm h^2 to the platina-faced spring h^4, thence through the paper to the earth.

If a negative current passes in the opposite direction nearly all friction between the platina plate and the paper ceases, and the diaphragm of the resonant box n retains its normal position.

When the positive current passes through the same channel the normal friction of the paper is augmented, and the chemical surface acting upon the platina spring arm serves to give a forward movement to the diaphragm of the resonant box.

Thus the mechanical force applied to move the chemical paper or surface acts with the electric current to produce the vibration of the diaphragm of the resonant chamber, and these vibrations will correspond to those of the diaphragm b made by speaking in the tube a.

The principle of this method of obtaining motion by electro-chemical decomposition is, that when a moving surface is in contact with a slightly yielding substance the tendency is to move the latter by and with the former. If the circumstances of contact are varied the adhesion of the surfaces will be sufficient to cause the moving surface to move the yielding substance or else to cause the yielding surface to slip more freely, and by its spring go in the opposite direction to the moving surface.

The passage of electricity at the surfaces in contact will change the frictional adhesion, making it more or less according to the substances employed. By balancing the mechanical forces so that when the surfaces in contact are not electrified the moving surface carries with it the yielding surface, and when electrified the yielding surface slips back, over the moving surface a mechanical movement is obtained that is dependent on the electrical condition of the surfaces in contact.

When it is requisite to obtain very perfect articulation, and when loudness is not essential, I adopt a modification shown in Fig. 12 of the device for compressing and expanding the tuft of conducting fiber, which modification consists in placing between the diaphragm 10 and the fiber t a vibrating tongue 21 of steel, permanently magnetized, and arranging it to act in the same manner upon the tension regulator t as if it was the diaphragm. I replace the cork upon the diaphragm by a thim armature of iron 22, which is in close proximity to the magnetized tongue, which tongue is secured at one end like an acoustic reed. In this position the

diaphragm is free to move, and at its approach to and recession from the magnetized tongue causes said tongue to follow its movements by magnetic attraction, and thus the tongue is made to perform what the diaphragm previously performed in varying the tension of the electricity on the line.

A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice. The circuit with this plate is completed through one or more tension regulators placed around its edges.

In practice I combine with the speaking or telephonic apparatus signal bells so arranged that when the telephone is not in use the line is thrown upon the bell by a switch, which also acts as a call on the bell.

One feature about the bells is that the magnet which serves to actuate the bells is made of very high resistance, using preferably German silver wire in the helix, and thus serve to prevent a rapid consumption of battery power. A large number of telephonic wires may be worked from one battery if these bells are used. The method I adopt for coating non-conducting substance with metallic substance is the reduction to the metallic state of metals from their salts by exposing them to the fumes which arise from the moist phosphide of a metal, such as phosphide of calcium, or by placing the silk for instance in a sealed tube provided with metallic electrodes, and volatilizing the electrodes by the passage of electric sparks. Such volatilized metals settle upon and coat the silk.

When great loudness is desirable, as in factories, the tympan of the receiving instrument may be made to control an air valve of a reservoir in which air is stored under a regulated pressure. The air allowed to escape will act with great power upon a local diaphragm. This diaphragm to obtain clear sounds requires a damper to check prolonged vibrations. It must be dampened by holding the fingers against it, or by a tightly stretched cord rubbing against it, or by a screw provided with a rubber tip held against it.

In some instances I make a record of the sound by the movements of the diaphragm, using for that purpose a strip of paper moved along regularly between two rollers 25, 26, as in Figs. 14 and 15, and there is a smooth thread or fine wire of soft metal 30 between the paper and the upper roller 25, and moving along with it. The diaphragm 10 of the resonant box is connected by a delicate rod 28 with this thread or wire as near to the bight of the roller as possible, there being a fork or eye through which the thread passes; hence deflections or bends are made in the thread or wire just before it is embedded into the paper by the pressure of the rollers. This may be used to reproduce the sound by vibrating a resonant diaphragm by the undulations of the groove made by the thread or cord.

By placing the fibrous-tension regulator within a small band of India rubber the same is rendered more elastic and the fiber is allowed to expand by the heat of the current without altering the electric tension.

In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympan 10, Fig. 17, a small cylinder t^1 of hard rubber or non-conducting material within which is the fibrous tension regulator t resting upon a piece of platina foil connected to one pole of the battery, and within this cylinder t^1 is a disc t^{10} of iron or other metal loose but pressed towards the tension regulator by a spring t^9 and screw cap t^8 and the other electric conductor is connected wit the said spring.

The inertia of the metal disk causes more or less compression of the tension regulator as the diaphragm is vibrated and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk t^{10} to a yielding spring t^{11} that extends across from one edge of the diaphragm to the other as seen in Fig. 16. This construction of tension regulating device is especially available with large diaphragms.

In some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm so as to check or dampen any prolonged or

false vibration and render the sound more clear and free from prolonged tones. In preparing the tension regulator I find in some cases that it is preferable to use lampblack mixed with pure plumbago, amorphous phosphorous, and a very small amount of nonconducting material such as rubber dissolved in a solvent that will entirely evaporate.

In Fig. 19 I have represented the circuit as passing through the diaphragm 10, tension regulator *t*, and a Daluc's dry pile battery D, P, B, to the earth. This battery is composed of about 300 pairs of paper disks coated with silver and black oxyd of manganese.

Fig. 20 illustrates the device before mentioned for intensifying the sound; 10 is the diaphragm vibrated by the sound; 42 is a valve moved by such diaphragm; 43 is a reservoir containing air under a given pressure; *b* is the diaphragm against which the air allowed to escape by the valve acts, and *t* is the tension regulator to transmit the electric pulsations, or a hearing resonant case may be applied at the same place.

Fig. 24 represents the diaphragm 10, tension regulator *t* with its adjusting screw and local circuit containing the battery B passing through a primary induction coil 49, and there is a key 50 in the same circuit. A secondary induction coil 51 is in the line circuit and is influenced electrically by the change of tension in the local circuit by the vibrations of the diaphragm 10. The secondary coil is sometimes required with many layers of fine wire to set up a current of high tension to overcome the inductive effect from the line wires; being adjacent to each other I place the receiving instrument at the distant station between the induction coil and the earth as at R, and use an electro-magnet E, M, with polarized armature to strike a bell; this will respond when the key 50 in the local circuit at the distant station is opened and closed.

In Fig. 25 a similar induction coil 49 and local circuit is represented, but the tension regulator is made of platina foil upon the surface of two soft rubber tubes, one on the diaphragm, the other on the adjusting screw. A shunt and rheostat at R' serves to prolong the magnetism in the induction coil, and thus ensure a gradual rise and fall of electric tension in the line instead of a cessation of the same when the platina surfaces separate, and at the receiving diaphragm *c* the rise and fall of electric tension in the line and its helix acts upon the permanent magnet to produce the vibrations of the diaphragm *c*, and by connecting a shunt around the helix, and placing therein the secondary battery S, B, composed of metallic plates in acidulated water, the action is rendered more uniform and the sound distinct.

When the diaphragm is arranged as in Fig. 26 to act upon a spring 56 through an intervening piece of soft rubber, said spring 56 produces rise and fall of electric tension by employing a range of resistances 57 with spring tongues adjacent to 56. The greater amplitude of vibration of the diaphragm the more direct will be the electric circuit connections, and the less resistance, because the circuit will pass along the spring instead of going through all the resistance coils.

When several line wires run near each other the wire used for the acoustic or speaking telegraph is influenced by induction, and false sounds will be produced. I counteract this tendency by placing one or more electro-magnets 59, Fig. 28, in the circuit of the speaking telegraph, and one or more electro magnets 60 in the circuit of the adjacent wires, and bringing the opposite cores of 60 at such a distance from the cores of 59 that a certain magnetic action will be set up in 59 by induction, in the opposite direction to the induction currents from the adjacent line or lines.

By adjusting the distance between these magnets when the speaking telegraph is not in use, until there is not any sound at the diaphragm from the induction currents, then these currents will be neutralized whether strong or weak, and will not produce any false sounds when the speaking telegraph is in use. I also employ double coils of wire for the same purpose, one coil being in the acoustic wire, and the other in the wire to be compensated.

A convenient form for the sound recorder or phonograph is to employ a cylinder 61, see Fig. 29, having a helical groove in its surface covered with tin foil, and the

cylinder is revolved regularly by clockwork, and moved endwise by a screw on its shaft so that the indenting point l^1 from the diaphragm 10 of *h* will be always in line with such groove, hence the vibrations of the diaphragm will be recorded by indenting the foil into the groove, and hence the same sound will be reproduced by the point l^2 of the hearing instrument *n*, giving to the diaphragm of *n*, the motions that result from the indentations of the foil moving in contact with such point.

The foil may be on a flat grooved plate, and be indented and act as before named.

I would observe in conclusion that I do not claim generally the transmission and reproduction of sounds by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying Drawings, except as hereinafter mentioned, but I claim as my Invention:—

First. In an Instrument for transmitting electric impulses by sound, a diaphragm or tympan of mica substantially as set forth.

Second. In an Instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of an electric tension regulator substantially as hereinbefore described for varying the resistance in a closed circuit, substantially as set forth.

Third. In a telegraphic apparatus operated by sound, a receiving instrument provided with a resonant surface in combination with a frictional surface, moved by power, and acting in connection with the electric current to vibrate such resonant receiver, and produce tones corresponding to those at the transmitting apparatus substantially as set forth.

Fourth. The method herein specified of recording the undulations of the diaphragm on yielding material, and the reproduction of sound by such material acting upon a diaphragm, to communicate to the same vibrations similar to the original ones, substantially as set forth.

In witness whereof, the said Edison Telephone Company of London, Limited, have caused their common seal to be hereunto affixed, the Twelfth day of November, One thousand eight hundred and seventy nine.

Company's Seal.

E. P. BOUVERIE, *Chairman.*
G. E. GOURAND, *Director.*
ARNOLD WHITE, *Secretary.*

To the Commissioners of Patents for Inventions.

I hereby grant my fiat, giving leave to the above named Edison Telephone Company, of London, Limited, the assignees of the said Letters Patent, to file in the Great Patent Seal Office, with the Specification to which the same relates, the above written Disclaimer and Memorandum of Alteration, upon condition that no proceedings be taken in respect of any transmitters actually made and completed prior to the date of the filing of the said Disclaimer and Memorandum of Alteration.

Particulars of numbers, and identifying marks to be verified by Statutory Declaration.

JOHN HOLKER,
Attorney-General.

Dated this 9th day of February 1880.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.

A.D. 1877 . . . . . N° 2909**.

Controlling by Sound the Transmission of Electric Currents and the Reproduction of Corresponding Sounds at a Distance.

THE UNITED TELEPHONE COMPANY'S DISCLAIMER AND MEMORANDUM OF ALTERATION.

[EDISON'S PATENT.]

Filed 13th June 1881.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, THE UNITED TELEPHONE COMPANY LIMITED, send greeting. WHEREAS Her most Excellent Majesty Queen Victoria, by Her Royal Letters Patent under the Great Seal of Great Britain and Ireland, bearing date at Westminster the Thirtieth day of July, in the year of our Lord One thousand eight hundred and seventy seven, in the forty first year of Her reign, did, for Herself, Her heirs and successors, give and grant unto Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, his executors, administrators, or assigns, Her special license, full power, sole privilege and authority, that he, the said Thomas Alva Edison, his executors, administrators, or assigns, or such others as he, his executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention of "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE," for and during the term of fourteen years thence next ensuing: And whereas in pursuance and performance of a proviso in the said Letters Patent contained, the said Thomas Alva Edison, did, within six calendar months next after the date of the said Letters Patent, cause a Specification in writing under his hand and seal, purporting to particularly describe the nature of the said Invention, and in what manner the same was to be performed, to be duly filed in the Great Seal Patent Office: And whereas by indenture bearing date the Second day of August, One thousand eight hundred and seventy nine, and made between the said Thomas Alva Edison, of the one part, and said Edison Telephone Company of London Limited, of the other part, the said Thomas Alva Edison, assigned unto the said Edison Telephone Company of London, Limited (*inter alia*), the said hereinbefore recited Letters Patent, and all rights, powers, authorities,

[*Price* 6*d*.]

privileges, advantages, profits, emoluments, and benefits to the said Letters Patent appertaining or belonging: And whereas on the Thirteenth November, One thousand eight hundred and seventy nine, the said Edison Telephone Company of London, Limited, petitioned the Commissioners of Patents for leave to amend certain parts of the said Specification of the said Letters Patent, which petition was referred to Her Majesty's late Attorney General, Sir John Holker, and leave was given to the said Edison Telephone Company of London, Limited, to file in the Great Seal Patent Office a Disclaimer and Memorandum of Alteration, as appears by the fiat of the said Sir John Holker, dated the Ninth day of February, One thousand eight hundred and eighty, and the said Disclaimer was duly filed in the Great Seal Patent Office on the Tenth day of February, One thousand eight hundred and eighty: And whereas by indenture bearing date the Twelfth day of July, One thousand eight hundred and eighty, and made between the said Edison Telephone Company of London, Limited, of the one part, and us, the said United Telephone Company, Limited, of the other part, and duly registered in the Great Seal Patent Office, the said Edison Telephone Company of London, Limited, assigned to us, the said United Telephone Company, Limited, the said Letters Patent, and the rights and privileges thereby granted, and the same thereby became and are now vested in us, the said United Telephone Company, Limited: And whereas, since the filing of the said Disclaimer and Memorandum of Alteration, and very recently, that is to say, about the First March, One thousand eight hundred and eighty one, your petitioners have ascertained that shortly prior to the application for the said Letters Patent, a description of the Invention of the said Thomas Alva Edison, in so far as it relates to the electro chemical receiver as covered by the third claim, was published in an American newspaper and afterwards copied into an English paper, and we are advised that, although there was no Invention by any one in England, or elsewhere, other than the said Thomas Alva Edison, of the said part of his Invention, the aforesaid publication renders doubtful the validity of the said third claim, and we are desirous of striking out the same, and of altering the numbering of the succeeding claim accordingly, in manner more fully hereafter appearing. NOW KNOW YE, that we, the said United Telephone Company, Limited, by and with the leave of Her Majesty's Attorney General, and for the reasons aforesaid, do alter the said Specification by striking out of the Specification as amended by the said Disclaimer, printed by the Queen's Printers, and published at the Great Seal Patent Office, in One thousand eight hundred and eighty, the whole of the third claim, comprising lines twenty to twenty four, both inclusive, on page 9. We also strike out the word "Fourth" at the commencement of line twenty five of the said page 9, and substitute therefor the word "Third."

We also desire to correct a clerical error, occurring in the said amended Specification by striking out the figure "2" which follows the reference letter "g" in line forty seven of page 5 of the said printed copy of the said Specification, and of substituting therefor the figure "3."

And in order that the effect of the said Disclaimer may be clearly understood, we annex hereunto a copy of the said Specification, as it will appear when so amended, the preamble and testing clause being omitted.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Royal Letters Patent, under the Great Seal of Great Britain and Ireland, bearing date at Westminster the Thirtieth day of July, in the year of our Lord One thousand eight hundred and seventy seven, in the forty first year of Her reign, did, for Herself, Her heirs and successors, give and grant unto Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, his executors, administrators, or assigns, or such others as he, his executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention of "IMPROVEMENTS IN

INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE," for and during the term of fourteen years thence next ensuing: And whereas, in pursuance and performance of a proviso in the said Letters Patent contained, the said Thomas Alva Edison did, within six calendar months next after the date of the said Letters Patent, cause a Specification in writing under his hand and seal, purporting to particularly describe the nature of the said Invention, and in what manner the same was to be performed, to be duly filed in the Great Seal Patent Office: And whereas, by an indenture bearing date the second day of August, One thousand eight hundred and seventy nine, and made between the said Thomas Alva Edison of the one part, and us, the Edison Telephone Company of London, Limited, of the other part, the said Thomas Alva Edison assigned unto us, the said Edison Telephone Company of London, Limited (*inter alia*), the said hereinbefore recited Letters Patent, and all rights, powers, authorities, privileges, advantages, profits, emoluments, and benefits, to the said Letters Patent appertaining or belonging:

And whereas, since the date of the said assignment, we have been advised and have ascertained that the said Specification contains matters which are of doubtful novelty, or which are not of sufficient practical value and utility to justify their retention, and we are therefore desirous of striking out the whole of the claiming clauses contained in the said Specification, with the exception of the first, second, eighteenth, and twentieth claiming clauses, and of striking out parts of the description contained in the body of the said Specification, and also of otherwise altering the said Specification and correcting certain clerical errors contained in the said Specification, in manner more fully hereafter appearing.

NOW KNOW YE, that we, the said Edison Telephone Company, of London, Limited, by and with the leave of Her Majesty's Attorney General, and for the reasons aforesaid, do alter the said Specification by striking out of the said Specification printed by the Queen's Printers, and published at the Great Seal Patent Office in One thousand eight hundred and seventy nine, the words "the same," which occur on page four at the end of line nine and the beginning of line ten respectively, and substituting therefor the words "a corresponding." We also strike out the word "the," which occurs between the words "and" and "electro" on the said page, line twenty two, and substitute therefor the word "an." We also insert between the words "the" and "instruments," which occur on the said page, line twenty five, the word "transmitting," and we strike out the letter "s" at the end of the said word "instruments." We also strike out the word "are," which occurs on the same line, and substitute therefor the word "is." We also insert between the words "in" and "Figs." (an abbreviation of the word Figures), which occur on the same line, the words "section in," and we strike out the letter "s" in the said word "Figs." We also strike out the words commencing with "and" on the said line twenty five, and ending with the first word "instrument" on line twenty six of the said page four. We also strike out the words "of the," which occur between the figure "2" and the word "receiving" on the said line twenty six, and substitute therefor the words "represents a." We also add after the word "instrument" at the end of the said line twenty six the words "which may be employed with it." We also strike out the word "The" at the commencement of line twenty seven on the said page four, and substitute therefor the words "Referring to Figure 1 the." We also strike out that portion of the Specification commencing with the words "In Fig." on page five, line forty one, and ending with the word "sound" on page six, line three, we also strike out that portion of the Specification commencing with the words "I also" at the end of line eight, and ending with the words "the line" on line eleven of the said page 6. We also strike out the whole of lines twenty four to twenty eight inclusive on the said page 6. We also strike out the words "to record," which are repeated on line thirty five of the said page 6 and add the letter "s" to the word "rest," which occurs on line of forty seven of the said page 6. We also strike out of page 8 lines thirty seven to forty two inclusive and lines

forty six to fifty three inclusive. We also strike out of page 9 lines eighteen to twenty three inclusive and lines thirty seven to forty one inclusive. We also strike out of page 10 lines seventeen to thirty seven inclusive. We also strike out of page 11 lines ten to thirteen inclusive and lines forty four to fifty seven inclusive, and we add at the end of line thirty seven of the said page eleven after the word "named" the words following:—"I would observe in conclusion that I do not claim generally the transmission and reproduction of sound by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying Drawings, except as hereinafter mentioned; but we also strike out the word "an," which occurs between the words "of" and "electric" on line 42 of the said page 11; and we add the letter "s" to the word "regulator," which occurs on the same line 42, to make it read "regulators," and after the said word "regulators" we insert the words "substantially as hereinbefore described." We also strike out of page 12 lines one to thirty inclusive, lines thirty six and thirty seven, and lines forty two to fifty six inclusive. We also strike out the word "Eighteenth," which occurs at the commencement of line thirty one on the said page 12, and substitute therefor the word "Third." We also strike the word Twentieth, which occurs at the commencement of line thirty eight of the said page 12, and substitute in therefor the word "Fourth." We also strike the work "or," which occurs on line thirty nine of the said page 12, and substitute therefor the word "on." We also strike out of page 13 lines one to fourteen inclusive. And in order that the effect of the said Disclaimer may be clearly understood, we annex hereunto a copy of the said Specification as it will appear when so amended, the preamble and testing clause being omitted.

This Invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and a corresponding sound is produced at the receiving station, so that oral communications can be sent by electricity and clearly distinguished at the receiving station.

Musical tones may also be sent, but my present Invention is especially available in transmitting and receiving oral communications.

In transmitting musical tones the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent, but in speaking there is little change in the musical tone, but considerable in the modulations and inflections of the voice.

In my present Invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line, with such accuracy that the electric pulsations or waves will represent the atmospheric sound waves produced by articulation, and an electro magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate.

The transmitting instrument in a complete form is represented in section in Figure 1, and Figure 2 represents a receiving instrument which may be employed with it.

Referring to Figure 1, the resonant tube or box *a* is of a size and shape adapted to being spoken into, the same having an opening at one end or side, and a diaphragm or diaphragms *b* against which the sound waves from the human voice act, and these and the motion that the diaphragm receives is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery B connected to the line *l* will transmit a greater or less current to the distant electro magnet *m*, Figure 2, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate *c* and develop sound corresponding to the articulation at the transmitting station.

The general features thus described pervade my entire Invention, but in developing the same many useful and important modifications and variations have been made, which I will proceed to set forth.

For convenience the speaking instrument, Figure 1, is provided with a handle a^1 and flexible conductors to the battery and line respectively, so that it may be handled and brought to the mouth; and in like manner it is preferable to place the hearing instrument, Figure 2, in a moveable handle b^1 so that it can be placed with the plate *c* against the ear; this brings the sound close to the organs of hearing, and the resonant plate touching the ear increases the distinction of the sound, and prevents any false or prolonged vibrations of the plate.

In some of the modifications I have shown the speaking instrument as a fixture, and also the hearing instrument as a fixed resonant tube, these being variable to suit the persons or the places.

The first especial feature that requires separate consideration is the peculiarity of the resonant tube for the voice; I have experienced great difficulty in reproducing the sound of the hissing consonants, such as S; this appears to arise from the fact that this sound is deflected downwardly in leaving the mouth, and does not act distinctly upon the diaphragm. By providing an edge in the resonant tube below the mouth upon which such consonant sounds are received, the vibrations are given either to the resonant tube or deflected to the diaphragm. I find it preferable to employ a hole *e* at the lower part of the mouth piece, against the edges of which the downward sound waves are directed. The same effect will be produced by a vibrating edge placed in the lower part of the mouth piece, or the opening into the resonant box may be contracted to about half an inch in diameter to effect the same purpose. The next feature requiring consideration is the character of the diaphragm in the speaking instrument.

Many materials have been employed by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of these produce a prolonged or secondary vibration from their own resonant character, hence the articulation is defective and the sound vibrations blend.

After extensive experiments I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when secured at its edges responds with the greatest accuracy to the sound vibrations, and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diagram or tympan.

I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension resulting from more or less resistance in the line. This resistance may be produced in several ways; I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts or discs of some conducting elastic fiber, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator, it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fibre expands. This fiber is placed in a small roll *f* between the delicate diaphragm spring *u*, Figure 9, and the variable presser *v*, adjustable by screw or otherwise in the electric circuit at this point, or it may be within a cavity in said presser *v*, as in Figure 1, there being a delicate cork centre piece *w* to the diaphragm *b* with a piece of platina foil *x* in contact with the fibre. In all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina or similar material, extending to the centre from the line or battery connection.

The fibre is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, the conducting power varying with the density of the tuft or branch of fiber.

The delicate spring *u*, Figure 9, upon the mica diaphragm *b* is easily secured by solder passing into fine holes bored in the mica.

In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact, such as would result from a disk covered with plumbago placed adjacent to a diaphragm also covered with plumbago or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit.

I sometimes perforate the diaphragm 10, Figure 18, and place a strip of elastic material 40 across said diaphragm over the hole, and upon this a piece of foil, so that the same responds to very weak vibrations, and in some instances two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters, or tensions, so as to respond to varying sounds or acoustic conditions, the various tension regulators being all in the electric circuit; this will produce greater rise and fall of tension for longer lines in consequence of the diaphragms acting simultaneously on the tension regulators.

In some instances it is preferable to make the mouth piece of the speaking instrument sufficiently large or flaring to receive all the sound vibrations, whether coming from the mouth, nose, or throat.

The tension regulator formed of fiber and conducting or semi-conducting material may be either dry or moistened with a liquid.

In some instances I make use of the best quality of lamp black retained within a case to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm.

I am enabled to record the sounds produced by the human voice or otherwise by causing the movements of the diaphragm to be registered on paper or soft sheet metal, and then the paper may be used in an instrument to reproduce the sound upon a delicate diaphragm by giving to the same a vibration similar to that originally given by the voice.

h, Figure 4, is the indenting transmitter, the diaphragm having a knife edge point; *i* is the paper which has previously been passed through a machine to raise a U shaped rib 6. The movement of the diaphragm of *h* when the drum is in motion causes the knife edge point l^1 to indent the raised rib to varying depths according to the amplitude of vibration of the diaphragm, thus these indentations represent accurately all the tones and varying inflections of the human voice. The paper after being indented is passed through a second apparatus *n*, Figure 5, almost similar to *h*. A spring 9 has a knife edge which rests upon the raised indented rib 6 the spring being connected to a delicate diaphragm 10 by a string or straw.

The indented rib reproduces in the spring 9 the movement of the indenting point and either by direct action or through the vibration of a string conveys the same motion to the diaphragm of *n*, and reproduces previous sounds. If these sounds are to be transmitted over a telegraph line, the diaphragm 10, see Figure 6, is provided with a cork disk *w*, and fibrous tension regulator *l* before described, to produce the rise and fall of electric tension on the line. The sound may be recorded in ink, as represented in Figure 7. The diaphragm of *h* operates a very flexible self feeding pen *o*, and causes the continuous line to be wide or narrow according to the amplitude of vibration of the diaphragm. The ink used should dry quickly, and the strip may be passed at any time thereafter through the instrument shewn in Figure 8, beneath the arm 12, having a point or points resting on the paper; this arm is connected with a resonant diaphragm, and the ink marks produce more or less friction according to the breadth and amount of ink deposited, and this will set the diaphragm of *n* vibrating and reproduce the vibrations of the diaphragm of *h*.

An obvious modification would be to coat the paper with a substance which would cause considerable friction, or even rough unsized paper might be used, and a spring provided with a burnished point rather flat would cause the surface of the paper to be made smooth more or less according to the vibration of the diaphragm,

and the difference in the surface of the paper would produce a response of the receiving diaphragm.

I sometimes arrange the battery in connection with the transmitting instrument, as shewn in Figure 10.

h is the resonant chamber, at the end of which is the diaphragm 10, and at each side of this diaphragm there are springs c^2, c^3, having points made of compressed plumbago mixed preferably with gum rubber, but any substance not liable to rapid decomposition, or the elastic or fibrous tension regulator aforesaid may be used. These points face each other on opposite sides of the diaphragm and make contact with platina foil disks secured to the diaphragm.

The spring c^3 passes through a hole or small slot in the side of the chamber *h*; d^1, d^2 are the main batteries; the battery d^2 has zinc to the line or spring c^2, and the battery d^1 has copper to the line or spring c^3. When the springs c^2 and c^3 are adjusted to make contact with the diaphram equally no current passes to the line, but when the diaphragm is vibrated its movement to one side, say, c^3, causes a greater pressure upon the plumbago on that spring and a loosening of the pressure on the plumbago on c^2, hence the balance of the batteries c^2 and c^3 will be destroyed, c^3 having the advantage will send a negative current to line; upon the return of the diaphragm the battery currents will again neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery d^2 will send a positive current to the line.

As the tension regulator of fiber or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speakers voice is strong or weak.

In Figure 11 is shewn the contact spring, which may be used adjacent to the diaphragm at one or both sides thereof; e^3 is a U shaped spring secured to the screw e^4, which is adjusted back and forth by the thumb nut e^5; e^6 is the pillar holding such screw; *r* is a piece of soft rubber or equivalent substance placed between the prongs of the spring e^3; e^7 is a wire or band which serves to bind the prongs tightly against the rubber *r*, so as to prevent the prongs acting as a tuning fork and transmitting harmonic vibrations not desirable; r^2 is the plumbago contact point. The object of the U spring and rubber is to present a semi rigid point for contact so as to prevent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm.

In Figure 3 the diaphragm of the receiving instrument is vibrated by a strip of paper chemically prepared, that is, in motion, the pulsations of electricity passing over the line and producing more or less friction between the paper and an arm upon the diaphragm.

The resonant box or chamber *n* is provided with a diaphragm as aforesaid, and to said diaphragm an arm h^3 is connected. At its outer end is an adjusting screw h^2 that presses upon a platina faced spring h^4 that is secured to this arm, and said spring rests upon the strip of paper that passes over the drum h^5.

The paper is moved slowly by rotating the drum h^5, and the waves of electricity coming over the line pass through the arm h^3 to the platina-faced spring h^4, thence through the paper to the earth.

If a negative current passes in the opposite direction nearly all friction between the platina plate and the paper ceases, and the diaphragm of the resonant box *n* retains its normal position.

When the positive current passes through the same channel the normal friction of the paper is augmented, and the chemical surface acting upon the platina spring arm serves to give a forward movement to the diaphragm of the resonant box.

Thus the mechanical force applied to move the chemical paper or surface acts with the electric current to produce the vibration of the diaphragm of the resonant chamber, and these vibrations will correspond to those of the diaphragm *b* made by speaking in the tube *a*.

The principle of this method of obtaining motion by electro chemical decomposition is that when a moving surface is in contact with a slightly yielding substance the tendency is to move the latter by and with the former. If the circumstances of contact are varied the adhession of the surfaces will be sufficient to cause the moving surface to move the yielding substance or else to cause the yielding surface to slip more freely, and by its spring go in the opposite direction to the moving surface.

The passage of electricity at the surfaces in contact will change the frictional adhesion, make it more or less, according to the substances employed. By balancing the mechanical forces, so that when the surfaces in contact are not electrified the moving surface carries with it the yielding surface, and when electrified the yielding surface slips back over the moving surface a mechanical movement is obtained that is dependent on the electrical condition of the surfaces in contact.

When it is requisite to obtain very perfect articulation, and when loudness is not essential, I adopt a modification shewn in Figure 12 of the device for compressing and expanding the tuft of conducting fiber, which modification consists in placing between the diaphragm 10 and the fiber *t* a vibrating tongue 21 of steel permanently magnetized, and arranging it to act in the same manner upon the tension regulator *t* as if it was the diaphragm; I replace the cork upon the diaphragm by a thin armature of iron 22, which is in close proximity to the magnetized tongue, which tongue is secured at one end like an acoustic reed. In this position the diaphragm is free to move, and at its approach to and recession from the magnetized tongue causes said tongue to follow its movements by magnetic attraction, and thus the tongue is made to perform what the diaphragm previously performed in varying the tension of the electricity on the line.

A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice. The circuit with this plate is completely through one or more tension regulators placed around its edges.

In practice I combine with the speaking or telephonic apparatus signal bells so arranged that when the telephone is not in use the line is thrown upon the bell by a switch which also acts as a call on the bell.

One feature about the bells is that the magnet which serves to actuate the bells is made of very high resistance, using preferably German silver wire in the helix, and thus serves to prevent a rapid consumption of battery power. A large number of telephonic wires may be worked from one battery if these bells are used.

The method I adopt for coating nonconducting substance with metallic substance is the reduction to the metallic state of metals from their salts by exposing them to the fumes which arise from the moist phosphide of a metal such as phosphide of calcium; or by placing the silk, for instance, in a sealed tube provided with metallic electrodes, and volatilizing the electrodes by the passage of electric sparks, such volatilized metals settle upon and coat the silk.

When great loudness is desirable, as in factories, the tympan of the receiving instrument may be made to control an air valve of a reservoir in which air is stored under a regulated pressure.

The air allowed to escape will act with great power upon a local diaphragm. This diaphragm, to obtain clear sounds, requires a damper to check prolonged vibrations. It must be damped by holding the fingers against it or by a tightly stretched cord rubbing against it or by a screw provided with a rubber tip held against it.

In some instances I make a record of the sound by the movements of the diaphragm, using for that purpose a strip of paper moved along regularly between two rollers 25, 26, as in Figures 14 and 15, and there is a smooth thread or fine wire of soft metals 30 between the paper and the upper roller 25 and moving along with it. The diaphragm 10 of the resonant box is connected by a delicate rod 28 with this thread or wire as near to the tight of the roller as possible, there being a fork or eye through which the thread passes; hence deflections or bends are made in the thread or wire just before it is embedded into the paper by the

pressure of the rollers. This may be used to reproduce the sound by vibrating a resonant diaphragm by the undulations of the groove made by the thread or cord.

By placing the fibrous tension regulator within a small band of india rubber the same is rendered more elastic, and the fiber is allowed to expand by the heat of the current without altering the electric tension.

In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympan 10, Figure 17, a small cylinder l^2, of hard rubber or non-conducting material, within which is the fibrous tension regulator *t* resting upon a piece of platina foil connected to one pole of the battery, and within this cylinder l^2 is a disc l^{10}, of iron or other metal, loose, but pressed towards the tension regulator by a spring l^3 and screw cap l^4, and the other electric conductor is connected with said spring.

The inertia of the metal disk causes more or less compression of the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk l^{10} to a yielding spring l^{11} that extends across from one edge of the diaphragm to the other, as seen in Figure 16. This construction of tension regulating device is especially available with large diaphragms.

In some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm, so as to check or dampen any prolonged or false vibration, and render the sound more clear and free from prolonged tones.

In preparing the tension regulator I find in some cases that it is preferable to use lampblack mixed with pure lumbago, amorphous phosphorous, and a very small amount of nonconducting material, such as rubber dissolved in a solvent that will entirely evaporate.

In Figure 19 I have represented the circuit as passing through the diaphragm 10, tension regulator *t*, and a Dulmo's dry pile battery D, P, B, to the earth. This battery is composed of about three hundred pairs of paper disks coated with silver and black oxyd of manganese.

Figure 20 illustrates the device before mentioned for intensifying the sound; 10 is the diaphragm vibrated by the sound; 42 is a valve moved by such diaphragm; 43 is a reservoir containing air under a given pressure; *b* is the diaphragm against which the air allowed to escape by the valve acts, and *t* is the tension regulator to transmit the electric pulsations, or a hearing resonant case may be applied at the same place.

Figure 24 represents the diaphragm 10, tension regulator *t*, with its adjusting screw and local circuit containing the battery B passing through a primary induction coil 49, and there is a key 50 in the same circuit. A secondary induction coil 51 is in the line circuit, and is influenced electrically by the change of tension in the local circuit by the vibrations of the diaphragm 10.

The secondary coil is sometimes required with many layers of fine wire to set up a current of high tension; to overcome the inductive effect from the line wires being adjacent to each other, I place the receiving instrument at the distant station between the induction coil and the earth as at R, and use an electro magnet E, M, with polarized armature to strike a bell; this will respond when the key 50 in the local circuit at the distant station is opened and closed.

In Figure 25 a similar induction coil 49 and local circuit is represented, but the tension regulator is made of platina foil upon the surface of two soft rubber tubes, one on the diaphragm, the other on the adjusting screw. A shunt and rheostat at R^2 serves to prolong the magnetism in the induction coil, and thus ensure a gradual rise and fall of electric tension in the line instead of a cessation of the same when the platina surfaces separate, and at the receiving diaphragm *c* the rise and fall of electric tension in the line and its helix acts upon the permanent magnet to produce the vibrations of the diaphragm *c*, and by connecting a shunt around the helix and placing therein the secondary battery S, B, composed of

metallic plates in acidulated water the action is rendered more uniform and the sound distinct.

When the diaphragm is arranged, as in Figure 26, to act upon a spring 56 through an intervening piece of soft rubber, said spring 56 produces rise and fall of electric tension, by employing a range of resistance 57 with spring tongues adjacent to 56. The greater amplitude of vibration of the diaphragm, the more direct will be the electric circuit connections and the less resistance, because the circuit will pass along the spring instead of going through all the resistance coils.

When several line wires run near each other the wire used for the acoustic or speaking telegraph is influenced by induction, and false sounds will be produced. I counteract this tendency by placing one or more electro magnets 59, Figure 28, in the circuit of the speaking telegraph, and one or more electro-magnets 60 in the circuit of the adjacent wires, and bringing the opposite cores of 60 at such a distance from the cores of 59 that a certain magnetic action will be set up in 59 by induction in the opposite direction to the induction currents from the adjacent line or lines.

By adjusting the distance between these magnets when the speaking telegraph is not in use until there is not any sound at the diaphragm from the induction currents, then these currents will be neutralized, whether strong or weak, and will not produce any false sounds when the speaking telegraph is in use.

I also employ double coils of wire for the same purpose, one coil being in the acoustic wire, and the other in the wire to be compensated.

A convenient form for the sound recorder or phonograph is to employ a cylinder 61, see Figure 29, having a helical groove in its surface covered with tin foil, and the cylinder is revolved regularly by clock work, and moved endwise by a screw on its shaft, so that the indenting point P from the diaphragm 10 of h will be always in line with such groove; hence the vibrations of the diaphragm will be recorded by indenting the foil into the groove, and hence the same sound will be reproduced by the point P' of the hearing instrument n, giving to the diaphragm of n the motions that result from the indentations of the foil moving in contact with such point.

The foil may be on a flat grooved plate, and be indented and act as before named.

I would observe in conclusion that I do not claim generally the transmission and reproduction of sounds by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying Drawings, except as hereinafter mentioned, but I claim as my Invention,—

First. In an instrument for transmitting electric impulses by sound, a diaphragm or tympan of mica, substantially as set forth.

Second. In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of electric tension regulators, substantially as hereinbefore described for varying the resistance in a closed circuit, substantially as set forth.

Third. The method herein specified of recording the undulations of the diaphragm on yielding material, and the reproduction of sound by such material acting upon a diaphragm to communicate to the same vibrations similar to the original ones, substantially as set forth.

In witness whereof, the said United Telephone Company, Limited, have caused their common seal to be hereunto affixed, the Twenty third day of March, One thousand eight hundred and eighty one.

The United Telephone Company, Limited.

JAMES BRAND,
Chairman.
JOSEPH B. MORGAN,
Director.
R. H. KRAUSE,
Acting Secretary.

To the Commissioners of Patents for Inventions.

I hereby grant my fiat, giving leave to the above named United Telephone Company, Limited, the assignees of the said Letters Patent, to file in the Office of the Commissioners of Patents for Inventions, with the Specification to which the same relates, the above written Disclaimer and Memorandum of Alteration, but nevertheless upon condition that no proceedings for infringement be taken against any one in respect of the first five thousand telephone instruments supplied or to be supplied under the contract between the Gower-Bell Telephone Company, Limited, and the Post Master General, dated the 28th March, 1881. Particulars, if required, of the marks by which such instruments may be identified to be delivered to the United Telephone Company, Limited, and verified by statutory declaration.

Dated this Fourth day of June, One thousand eight hundred and eighty one.

HENRY JAMES,
Attorney General.

The United Telephone Company, Limited, accepts and hereby undertakes to abide by the conditions imposed by the Attorney General and mentioned in the above mentioned fiat.

The United Telephone Company, Limited.

JAMES BRAND,
Chairman.
G. E. GOURAND,
Director.
R. H. KRAUSE,
Acting Secretary.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1881.

A.D. 1877, 31st JULY. N° 2927.

Instruments for Transmitting, &c. Telegraphic Messages.

(This Invention received Provisional Protection only.)

PROVISIONAL SPECIFICATION left by Thomas Alva Edison at the Office of the Commissioners of Patents on the 31st July 1877.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN INSTRUMENTS FOR TRANSMITTING, RECORDING, AND RECEIVING TELEGRAPHIC MESSAGES."

In my improvements a copy of the message sent by an ordinary key is preserved at the sending station, and the message is recorded at the receiving station, and it may be recorded at more than one station on the line, and the recorded message is used to transmit upon another circuit, or to repeat the message.

The record is made by indentations in a sheet of paper, but instead of the indentations being made in a long strip of paper the record is made in either a volute line upon a correspondingly grooved disc, or else upon a sheet of paper in a zig-zag line, over a cylinder that is correspondingly grooved. The paper is put upon the disc or cylinder in a predetermined position, regulated by register marks, so as to be held accurately in place, and the indenting point is upon an arm or slide that is kept in position by a corresponding groove, or volute, or otherwise, so that the indenting point is always over the groove in the metallic disc or cylinder, and will indent the paper down into the groove when the point is pressed upon the paper. The indenting point is operated by an electro-magnet, hence when the line connection is made through the electro-magnet there will be a record taken at the sending station of the message sent by an ordinary key, and the same record will be made at the distant station by a similar instrument.

In order to use the indented paper to transmit a message to a distant station the indentations are made to open and close a circuit breaker in the line or electric circuit, said paper being moved automatically beneath the circuit-breaking apparatus. The sheet may be reversed to work the circuit by the projections instead of the indentations.

Two receiving or transmitting discs are usually connected together for long messages, and the circuit connections and clutches to the actuating gearing are

[*Price* 2*d.*]

arranged so as to connect with one and disconnect from the other alternately, either with or without break in the message.

The sheets of indented paper can be preserved as a record, or used at any time for transmission or repeating the message.

A magnetic engine and governor are usually employed for giving motion to the parts that carry the paper so as to obtain uniformity of speed, or nearly so, in the different instruments, and the line is provided with local circuits, sounders, or calls for facilitating the business as usual; and in cases where it is preferred to make the record on chemical paper, or by ink, it may be employed in the same apparatus.

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1878.

A.D. 1878, 24th April. N° 1644.

Recording and Reproducing Sounds.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORD."

Sealed the 6th August 1878, and dated the 24th April 1878.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 24th April 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORD."

My present improvements are for more fully developing and perfecting the device heretofore invented by me, and known as the "phonograph."

By extensive experiment and research I have been enabled to obtain very perfect articulation and to produce a record in a convenient form for preservation.

The sound vibrations are made to move a point that by preference is a diamond or other very hard substance and of a peculiar shape. The sound vibrations in the atmosphere act upon a diaphragm or other body capable of motion, and the same moves the indenting point, and acts as a phonograph. The indented material is properly designated a phonogram, and it is preferably metallic. Sometimes tin-foil is used upon a grooved surface; sometimes a thin sheet or leaf of metal is placed upon a piece of paper having a surface of parafin or similar material.

Sometimes the metallic surface is copper, and where a matrix has been made of steel or iron by electrotype deposit, or otherwise, upon the phonogram it may be hardened and used for impressing a sheet or roller of metal, and thereby the original phonogram can be reproduced indefinitely in metal that may be hardened and used for any reasonable length of time to utter the sentence, or words, or sounds phonetically.

[Price 10d.]

Edison's Improvements in Recording and Reproducing Sounds.

The instrument or portion of the instrument that reproduces the sound from the phonogram I term a "phonet."

In order to facilitate production, use, and preservation of the phonograms I employ a ring or margin of thick paper or pasteboard, caused to adhere to the foil or sheet by resinous substance; this is used as a gauge in placing the sheet in the instrument or replacing the same in the phonet. I find that a disc revolved by gearing, and a weight or spring, and the movement regulated by a fan or governor, is a convenient device for presenting the surface to be indented to the phonograph, and the phonograph is on an arm that swings towards and from the centre of the disc, and is guided by grooves or other convenient mechanism.

The phonet device takes the place of the phonograph device when the sounds are to be reproduced.

When the sheet of material is wrapped around a cylinder its edges are passed down into a slit and held firmly. Either the cylinder may be moved endwise by a screw, or the phonograph or phonet devices be moved along the cylinder, and where the same sound is to be reproduced periodically, as calling out the hours of the day in a clock, or reproducing the sounds of animals in toys, the phonet is to be brought to the place of beginning automatically.

The phonographic devices employed by me are preferably a diaphragm of metal, against which the sound vibrations act. Sections of rubber tube applied to the surface act as dampers to prevent false vibrations; pieces of felt or similar yielding material may be used for the same purpose, and a small delicate hoop of spring metal between the diaphragm and the indenting point renders the phonogram more perfect than it would be if the diaphragm acted upon the point direct. A similar effect is produced by a disc upon the arm that carries the point, said disc being so close to the diaphragm that the atmosphere will produce the vibrations.

It is often advantageous to use a case between the mouth of the speaker and the diaphragm to gather or hold the sound, and in some instances the head of the speaker should be inserted into this case, up through a hole in the bottom. The mouth-piece is sometimes slotted or perforated, and has irregular edges to re-inforce the hissing sounds, and sometimes a membrane of rubber or gutta percha is fitted to the teeth, and forms a bag between the lips and the diaphragm.

The disc upon the arm that carries the point as aforesaid may be acted upon by a magnet, and the current through a helix from a diaphragm, or the motion of the arm and points may serve to set up a secondary current through such helix in consequence of the motion given by the phonogram to the point. The arm carrying the point in this latter case should be magnetised.

The phonogram may be produced by the direct action of air concentrated to the spot by a funnel terminating with a small hole, the end of the funnel being almost in contact with the moving surface to be indented.

When the foil is perforated instead of indented it can be rolled up in the form of a horn or cylinder, and revolved, and the articulation result from air blown from the end of a small tube passing through the perforations as they are presented in succession.

Leverage is sometimes employed between the diaphragm and the phonogram, either to lessen or increase the motion of the phonographic action in recording, or of the phonetic action in speaking, and for recording quartette, trio, and other characters of singing, two, three, four, or more phonographic devices are employed upon one cylinder or plate, and the sounds will be reproduced by corresponding phonets; or where singing is conveyed through tubes to one diaphragm the phonographic record will be the combined tones, and the reproduction by the phonet will be complete and correct.

I find that an arm at right angles to a diaphragm, with a point resting upon the phonogram, will reproduce the tones by the weight and leverage of the arm moving the diaphragm.

The phonogram may be in the form of a disc, a sheet, an endless belt, a cylinder, a roller, or a belt, or strip, and the marks are to be either in straight lines, spiral,

Edison's Improvements in Recording and Reproducing Sounds.

zig-zag, or in any other convenient form, so long as the apparatus is adapted to bringing the same into contact with the phonet or speaking part of the apparatus, and the reproduction of the phonogram from a matrix or copy in relief of an original phonogram may be made upon a belt, roller, cylinder, plate, or other convenient surface.

For amusement and instruction this phonograph is capable of extended use. For instance, a revolving cylinder containing phonograms of the letters of the alphabet and phonet keys, with corresponding letters on them, can be used in teaching the alphabet; and phonogram sentences, speeches, and other matters can be spoken by the phonet and repeated by the learner without the eyesight being called into use.

For amusement or instruction the phonogram can be of a dog's bark, a rooster's crow, a bird's song, a horse's neigh, a lion's roar, and the like, and the phonogram can be used in a toy animal with a single phonet for the reproduction of the original sound.

This phonograph or speaking machine applied to a mask produces a semblance of vitality if the phonogram is made to operate upon moveable lips by levers, and in the production of such a phonogram a portion of the surface is to be indented by delicate levers and points, receiving motion from the lips during articulation; thereby a correct reproduction of the motion of the lips is obtained.

In connection with the phonet it is important to avoid the sound that usually results from the rubbing action of the phonogram upon the point. I am enabled to prevent this by an electric action between the point and the phonogram. In this case the phonogram should be of iron, and the point of steel and the parts magnetised so as to slightly repel each other; the point will follow the undulations and reproduce the sounds by the phonet.

It is important that the point used in the phonet correspond in shape to that of the phonograph, but slightly smaller, so as to follow the bottom of the depressions without contact upon the sides.

The diaphragm or other body employed in the phonet to receive motion from the phonogram is connected with a funnel of paper or other resonant substance that acts as a sounding board to render the phonet louder and more distinct.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 22nd October 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORDS."

This Invention consists in means for recording in permanent characters the sounds made by the human voice in speaking and singing, these made by musical instruments, birds, animals, or any sound whatever, and in means for reproducing those sounds at any desired time.

The sound vibrations act upon a diaphragm or other body capable of motion; this diaphragm is at the back of a chamber provided with an opening or mouth-piece, and to this diaphragm an indenting point is secured. This instrument I term a "phonograph." The phonograph is adjusted to position with its indenting point contiguous to a moving surface covered with a thin sheet of metal foil or other suitable material, or else the surface with the metal foil is stationary, and the phonograph movable.

The surface upon which the metal foil is secured is by preference grooved spirally, and this indenting point indents the foil in the line of this groove as the diaphragm is moved back and forth by the sound vibrations; these indentations are a record of the sound waves, and form the characters for reproducing the sounds. This indented sheet I term a "phonogram."

The instrument or portion of the instrument that reproduces the sound from the phonogram I term a "phonet." It is similar in construction to the phonograph, being provided with a diaphragm and point, but the mouth-piece is by preference funnel-shaped to render the sound loud and distinct. The sounds are reproduced by the phonet being adjusted to place so that the point of its diaphragm is at the beginning of the spiral line of indentations, and as the surface containing the indented foil is moved the diaphragm of the phonet is vibrated by the point passing from one indentation to the next, hence the diaphragm receives the same movement from the indentations as when making those indentations, consequently the sounds made by the phonet will be the same as those that operated upon the diaphragm of the phonograph.

In the Drawing Fig. 1 is a section of the phonograph and sectional elevation of the mechanism for presenting the surface to be indented; and Fig. 2 is a plan of the same.

The phonograph is made of the body portion *a*, diaphragm *b*, and indenting point *c*. The body portion *a* has a central opening forming the mouth-piece into upon the diaphragm, and the diaphragm is secured at its edges to the body *a*, leaving a space between the body and diaphragm in order that the diaphragm may vibrate freely. The indenting point should be a diamond or other very hard substance.

The diaphragm is made of a thin sheet of iron or other material, and it is preferable to place the indenting point upon a delicate spring arm c^2, and to employ a short piece of rubber tubing c^3 between the spring and diaphragm; this rubber acts as a damper to prevent false vibrations of the diaphragm.

The phonograph is upon a lever arm *i* pivoted at 5 to the vertical stud 6, so that the phonograph may be raised or lowered vertically, or moved horizontally for a purpose hereafter explained.

It is now to be understood that if a person speaks with his mouth near the mouth-piece of the phonograph the sound vibrations will act upon the diaphragm, and vibrate it, and communicate to the indenting point a similar movement, and that if a piece of metal foil or other material susceptible of being indented is placed

beneath or behind the indenting point and caused to move regularly, or the indenting point moved over the material; that said material will be indented and form a perfect record of the sound vibrations.

I will now describe the means for sustaining the sheet to be indented, and the mechanism for moving the same:—*d* is a disk or plate secured to and turning with the shaft *e*, and hinged to this disk is a ring frame *f*; this disk *d* has two spiral grooves 3, 4, in its surface. There are pins 2, 2, upon the surface of the disk, and holes at corresponding places in the ring frame; the sheet to be indented is of a size and shape to correspond with that of the disk *d* and frame *f*, and said sheet has holes in it corresponding to the position of the pins 2, 2, and these holes form register marks in placing or replacing the sheet upon the disk *d*, and after the sheet is so placed the ring frame *f* is brought down upon the sheet and holds it firmly in place. There may be a central opening in the indented sheet of a size slightly larger than the space occupied by the spiral 3, and the outer edges of the sheet are stiffened by a ring of thick paper or pasteboard caused to adhere by glue or other adhesive material. The surface of the disk *d* is made with two spiral grooves 3 and 4 as aforesaid; the groove 3 is a guide for a pin that is upon an arm *g* on the phonograph, and the groove 4 is for the indenting point *c*. As the disk and sheet are revolved the groove 3 causes the indenting point to occupy a position immediately over the line of the spiral 4, and the indentations will be made upon the sheet of foil in a line corresponding to that of the spiral 4, shown in Fig. 2. The indentations made in the foil are a complete record of the sound vibrations that acted upon the diaphragm *b*, and from this indented sheet, which I term a "phonogram," the sounds are reproduced. The phonograph is carried outwardly by the spiral 3, and in so doing the parts swing upon the vertical stud 6. By depressing the outer end of the lever *i* the phonograph is raised so that it can be swung aside from the disk *d* to allow of the ring frame *f* being thrown back and the indented sheet or "phonogram" removed from the disk.

The shaft *e* is revolved by a weight, or spring, and gearing at *h*, and the spring is wound up by moving the lever *k* back and forth, which acts upon a ratchet and pawl of ordinary construction; *l* is a lever provided at its outer end with an inclined groove, in which is a pin on the lever *m*, and the other end of this lever *m* is connected with the coupler m^1 by moving the lever *l* one way or the other, the shaft *e* will be connected to or disconnected from the gearing *h*, and hence the disk *d* stopped or started at pleasure without interfering with the motor.

As it is necessary that the shaft *e* should be revolved with uniformity I provide a governor at *n* to prevent the apparatus revolving too rapidly; and this may be made as in Figs. 1, 3, & 4, in which there are metal blocks *o* at the ends of spring arms from a cross head on a shaft that is driven by the gearing *h*, said blocks swinging radially and acting against the interior of a stationary cylinder *p* if the speed becomes too great, thereby checking the speed by the friction of the blocks against the cylinder. These spring arms may be secured at one end to a prismatic block as shown in Fig. 5. It is preferable to cover the surface of the blocks or next the cylinder *p* with felt or similar material that will slide upon the interior surface of the cylinder *p*, but produce more or less friction, according to the centrifugal action.

The guide spiral 3 may be dispensed with, and either of the devices shown in Figs. 6, 7, 8, or 9, made use of.

In Figs. 6 and 7 the shaft *e* projects above the surface of the disk *d*, and there is a tooth upon the shaft contiguous to a rack bar extending from the phonograph, hence each revolution of the shaft, the rack bar, and phonograph will be moved the space of one tooth, consequently the lines of indentations will be parallel and concentric to the shaft *e*, excepting at the places when the tooth acts to move the rack bar and phonograph outward or inward. In this case the spiral grooves are cut to correspond to the feed.

In Fig. 8 a worm upon the shaft *e* acts upon a worm pinion to revolve the shaft e^5; and the worm at the other end of this shaft e^5 acts upon teeth around the base of

the lever i on the stud 6. By this device the phonograph will be moved outward gradually, and the line of indentations will be in a spiral corresponding to the continuous spiral groove in the plate d.

In Fig. 9 the shaft e is made with a fusee at p^1, and one end of a swinging arm connected to the phonograph takes against the same. The spirals of the fusee gradually move outward the phonograph, as the disk and shaft are revolved, and the line of indentations will be spirally the same as that made by the spiral 3.

In Fig. 10 the shaft e is provided with a screw pinion meshing with teeth upon a cam wheel 7. This gives the same movement to the phonograph as the spiral groove 3.

In Fig. 11 the guide groove 3 for the arm and pin g is upon a disk d^1 upon the shaft e, but the groove 3 occupies the same relative position upon the disk d^1 as the groove 4 upon the disk d, so that the phonograph is moved outwardly by the groove of the disk d^1, swinging both the arms g and i upon the vertical pivot 6.

Instead of the sheet of metal foil being upon the disk d it may be wrapped upon a cylinder q, as in Fig. 12. In this case the cylinder is upon a shaft e^1 revolved by the gearing at l^1, and upon said shaft there is a right and left hand screw at k^1, and there is a corresponding double spiral groove in the surface of the cylinder q. The phonograph is secured to a sliding shaft l^1, and said shaft is moved endwise back and forth by the screw k^1 acting upon an arm m^2 that is secured to the said shaft l^1. As the phonograph is moved in one direction the line of indentations is made spirally in the foil on the cylinder q, and when the arm m^2 reaches the end of the screw it will be moved in the other direction by the reverse screw thread, and the phonograph will make a second spiral line of indentations that will cross the first spiral line. This feature is especially available for a phonet where the surface of the cylinder q is formed of an electrotype or other copy of the phonogram, so that the words or sounds may be reproduced automatically and at intervals if desired.

It is preferable to make use of a thin metal plate m^3, see Figs. 13 and 14, pivoted at one end and fitting within a longitudinal groove in the surface of the cylinder q for securing the edges of the metal foil and holding it securely upon said cylinder. The top of this plate m^3 is flush with the surface of the cylinder, and grooved to correspond with the groves in the cylinder, so as not to interfere with the indenting point. A wire may replace this device, such wire being secured by arms at each end of the cylinder, and raised and lowered in and out of the groove by a cam or otherwise. I find that an interruption of one-eighth of an inch space where there is no recording is not detected by the ear.

The apparatus shown in Figs. 13 and 14 is similar to that shown in Fig. 12, except that the phonograph is stationary and the cylinder moves horizontally, and the shaft e^1 is only provided with a screw thread in one direction, hence the cylinder will have to be moved back by hand to bring it to place if desired to reproduce the sounds from the phonogram, or to position the phonograph if a new sheet of foil is to be indented after the first one has been removed. This is readily accomplished by raising the arm o^1 and its tooth from the screw k^1, which leaves the shaft e^1 and cylinder free to be moved back and forth.

In Fig. 15 the phonograph is fitted to move horizontally instead of the cylinder q, as in Fig. 12, but the shaft e^1 is provided with a screw thread in one direction only, hence the phonograph has to be positioned by hand after the arm o^1 has been raised from the screw k^1.

In Figs. 12 and 15 the phonograph can swing upon the shaft l^1 to raise the indenting point from the cylinder q, and allow for the removal or insertion of a sheet of foil, and there is a stop at 8 for adjusting the position of the phonograph when brought down to indent the foil.

In Figs. 13 and 14 the phonograph is upon an arm pivoted at 9, so that it can be swung horizontally away from the cylinder q for the purpose aforesaid, and the adjustable stop 8 is also provided.

Thus far I have described the "phonograph" or instrument upon which the

sound vibrations act, and which instrument acts to indent the sheet of foil and produce the "phonogram" or record of such sound vibrations.

Mechanism has also been described for presenting the sheet of foil to be indented by the phonograph.

I will now describe how the sounds are reproduced from the phonogram.

If it is desired to reproduce the sounds from the phonogram in the same instrument in which the phonogram was produced it is only necessary that the indenting point c be made to traverse the line of indentations in the phonogram, and that a funnel-shaped mouth-piece, shown by dotted lines in Fig. 1, be added to the phonograph to aid in increasing the loudness and distinctness of the sound. The instrument in this form I term a "phonet."

In the instrument shown in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, 14, and 15, the phonet requires to be positioned by hand, as before explained, in order that the point c may be placed at the beginning of the spiral line of indentations. As the point c passes from one indentation to the next, either by the foil being moved beneath said point, as in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, and 14, or by the point moving over the foil, as in Figs. 12 and 15, the diaphragm b receives a movement corresponding to the depth of the indentations, and corresponding also with the same movement it received from the sound vibrations when making those indentations, hence air waves will be produced by the movement of the diaphragm that will make sounds by passing through the mouth-piece of the phonet that will be exactly the same as the sounds that acted upon the diaphragm of the phonograph.

The material upon which the record is made may be of metal foil, such as tin, iron, copper, lead, zinc, cadmium, or a foil made of composition of metals.

Paper or other materials may be used, the same being coated with paraffine or other hydrocarbons, waxes, gums, or lacs, and the sheet so prepared may itself be indented, or the material, say paper, may be made to pass through a bath of hot paraffine and thence between scrapers. Thin metal foil is now placed on the material, and the sheet passed through rollers, which give it a beautiful smooth surface. The indentation can now be made in the foil, and the paraffine or similar material, and the indenting point, does not become clogged with the paraffine in consequence of the intervening foil.

If the copper foil, or tin foil with copper surface is used, and a matrix of iron or steel made by electrotype deposit or otherwise upon the phonogram, such matrix may be hardened and used for impressing a sheet or roller of metal as hereafter mentioned; thereby the original phonogram can be reproduced indefinitely in metal that may be hardened and used for any reasonable length of time to utter the sentence or words or sounds phonetically.

I will now briefly describe some modifications in the construction and operation of the phonograph and phonet.

In Fig. 16 the indenting point c is upon a spring arm c^2, as in Figs. 1 and 2, but there are short sections of rubber tube c^3 at each side of the diaphragm b to dampen the diaphragm and prevent false vibrations.

In Fig. 17, the rubber of the diaphragm acts against the outer end of the arm c^2 to increase the leverage and lessen the depth of indentations in the foil and allow of the record being made in less yielding material than tin foil.

Fig. 18 shows a modification of the last-mentioned device, the pressure being applied to the arm c^2 between the indenting point and the support for the arm so as to increase the depth of the indentations.

Fig. 19 shows the arm c^2 made as a lever with a spring.

Fig. 20 shows the indenting point upon the center of a spring bar that is firmly held at each end; the bar is connected at its center to the diaphragm b by a string or otherwise.

Fig. 21 represents the diaphragm b as of concave form instead of flat.

Fig. 22 shows the indenting point upon a spring secured to the diaphragm.

Fig. 23 shows a disk upon the spring e^3 of the indenting point; this disk is placed quite close to the diaphragm and is moved by the air as the diaphragm is vibrated, the disk being so close to the diaphragm that the two will vibrate together, as air cannot pass between or escape as rapidly as the vibrations take place.

Fig. 24 shows the diaphragm vibrated by electro-magnetism; in this case the diaphragm is to be of iron, and the power of the electro-magnet will be varied by a rise and fall of electric current passing through the helix of the electro-magnet; this rise and fall of electric tension is to be produced by the action of sound upon a diaphragm and connections in an electric circuit.

Fig. 25 shows the method of vibrating the indenting spring and point by the direct action of an electro-magnet without the use of a diaphragm, the electric tension in the helix being varied by sound vibrations upon a diaphragm.

Fig. 26 shows the spring arm e^2 connected to one end of a permanent magnet so as to highly magnetize the reproducing point; the foil should be of iron. When the point passes an indentation there will be less attraction than when passing no indentation; this will give good articulation free from the scraping noise of the point on the foil, for in this case it does not touch the foil, but is worked by magnetic attraction.

Fig. 27 represents two instruments in connection with the cylinder g; in this case the phonet and the phonograph are separate. The phonograph records in the usual manner, but the phonet has its diaphragm set in motion by the rise and fall of the lever e^1. This reduces the scraping noise of the foil and acts by leverage, and a slight tension to move the diaphragm as the phonogram is moved beneath the point a.

Fig. 28 shows an arrangemen whereby four persons may speak simultaneously and have records made in separate parallel lines upon one cylinder, and the phonogram will reproduce the sounds the same as though it contained the record of but one voice.

Fig. 29 shows a single phonograph adapted to receive the voices of three persons as in singing; the sounds made by the three voices are conveyed through flexible or other tubes to the diaphragm, and will be recorded in a single line of indentations, but when reproduced by the phonet the sounds uttered will correspond to the three voices.

In Fig. 30, the foil is sustained upon a hollow cylinder with a funnel-shaped end. The record is made upon the foil in the usual manner by the phonograph, excepting that holes are made entirely through the foil. A nozzle with a small opening is placed so that it will always be opposite the line of perforations as the cylinder is revolved. This nozzle is connected to a source of compressed air or other fluid, and every time a perforation comes opposite the nozzle, a puff of air passes into the cylinder and a sound is produced upon the principle of the siren. The nozzle may be placed on a spring to keep the end of the nozzle in contact with the line of perforations.

Fig. 31 shows the phonograph as made with a large chamber between the diaphragm and the mouth-piece; this is especially useful in collecting sound when the person speaking or the sound to be recorded is made several feet from the instrument.

Fig. 32 shows a device whereby the indenting point may be dispensed with in the phonograph. The funnel forming the phonograph is made with a diaphragm at the larger end or mouth-piece, and a very small hole at the pointed end adjacent to the foil on the cylinder g; this foil should be very thin so that the indentations will be made by the direct action of the air waves as concentrated by the funnel without the interposition of the indenting point.

Fig. 33 shows a phonet in which the phonogram or sound record has been made upon an endless belt; this is a convenient arrangement for toys, as the same may be made to imitate the bark of a dog or other noise made by an animal; and this

belt may be of steel or other hard material that allows the same to be used for a long period of time.

Fig. 34 is a perspective view showing a double phonet, there being a spiral line of indentations on each side of the revolving disk d, one phonet coming into action as the other finishes; in this case the spirals should be in opposite directions, so that the disk continuing to revolve in the same direction moves one phonet from the center outwards, and then the other phonet is connected and moved back towards the center; this may be used as a toy.

Fig. 35 represents a phonet in which the phonogram containing a sentence, speech, words, or other sound record is upon a belt or strip wound upon a reel; this belt is drawn along gradually and wound upon the second roller by any suitable mechanism, and as the phonogram is thus moved it actuates the phonet c, b.

Fig. 36 shows a phonograph or phonet similar to that shown in Fig. 12, the cylinder g is revolved, but remains in one position, and the phonograph or phonet is movable back and forth over the cylinder. In this instance the arm m^2 is extended beyond the screw l^1, and passes beneath the inclined spring guide m^3, when the screw is carrying the arm and phonograph towards the right; as the arm m^2 passes from beneath the end of the guide m^3 it is no longer held to the screw, and the arm m^2 and phonet are lifted by the guide m^3 as the springs m^4 draws the shaft, phonograph, and arm, along to the place of beginning at which place the arm m^2 drops off the end of the inclined guide m^3 into the thread of the screw, and as this revolves it carries the arm along beneath the guide m^3 as before.

Fig. 37 represents the phonograph or phonet upon a pivoted arm, so that it may swing across or at right angles to the line of movement of the intended material or phonogram. In this case the line of indentations may be lengthwise of the belt, or across the same in the arc of a circle.

Fig. 38 shows a phonograph similar to that shown in Fig. 31, except that the sound chamber is of a different shape.

Fig. 39 shows a mouth-piece with an orifice of soft rubber to fit the mouth or the lips of the person speaking, so that all sound waves will be confined to the chamber and diaphragm.

Fig. 40 shows the mouth-piece of the phonograph made with cross slots with irregular edges.

Fig. 41 shows the mouth-piece as perforated with numerous holes.

Fig. 42 shows but one opening in the mouth-piece; the edges of this are irregular. These irregular edges reinforce the hissing sounds and cause a more perfect phonogram to be produced.

Fig. 43 represents a mouth-piece of mica with a central opening protected at its edges by a wooden ring.

In Fig. 44, the diaphragm b is of wire gauze with a backing of paper connected to it by any suitable cement, and there is a ring of stiff paper at the edges of the gauze disk to strengthen it.

Fig. 45 represents a diaphragm b of parchment or similar material stretched tightly within the frame b^6 by cords and screws. The cords may be of different lengths and tension, and respond to and reinforce certain sounds.

Fig. 46 shows a mouth-piece for the phonet made in imitation of the human mouth.

Fig. 47 represents the body portion of the phonograph or phonet made triangular, and the diaphragm is of corresponding shape.

Fig. 48 represents three cylinders, each provided with a phonograph or phonet; this is useful in recording and reproducing three-part singing or music.

Fig. 49 represents a phonet made as a tube, with flaring or trumpet-shaped ends, and with two diaphragms 15, 16, placed crosswise of the tube so as to form an air chamber. There is a third diaphragm b, which is vibrated by the movement of the reproducing point a, and said diaphragm gives motion to the air in the chamber,

and vibrates the diaphragms 15, 16, which latter produce air waves, and the sounds issuing from the two trumpet-shaped ends will blend and increase the volume of sound.

Fig. 50 represents a device whereby deep indentations are made in the metal foil. Two diaphragms are employed, the first (b^3) is vibrated by the sound vibrations, and controls a valve b^1 in a tube connected with a source of compressed air or other fluid; this valve b^1 allows more or less air to pass to the diaphragm b, according to the vibration of the diaphragm b^3, hence the diaphragm b will vibrate in harmony with the diaphragm b^3, but it will be acted upon by greater force, and consequently the indentations will be deeper in the foil than if the diaphragm b was acted upon simply by the sound vibrations of the voice.

Figs. 51 and 52 represent a device that may be used with a phonet to increase the loudness of the sounds reproduced. The sound vibrations from the phonet are conducted by a tube shown by dotted lines in Fig. 51, to the diaphragm b^3 that controls a valve b^1 in a tube connected with a reservoir of air or other fluid under pressure, and the air as it escapes by the valve passes into the trumpet-shaped end of the tube, and produces sounds that are very loud and clear, and are a reproduction of the sounds resulting from the use of one of the phonets before described.

This same apparatus may be used to reproduce with louder utterances a person's voice, the the sound from the voice being used to vibrate the diaphragm b^3, and thereby regulate the air waves escaping from the valve b^1 into the trumpet.

Fig. 53 shows the speaker's head within a box or case; in this instance nearly all the sound vibrations act upon the diaphragm.

Figs. 54 and 55 illustrate how the movements of the lips in speaking may be recorded and reproduced. In this instance, a lever applied to the diaphragm carries the indenting point c, Fig. 55, and the end of this lever is placed in the mouth of the speaker, and the movement of the lips regulates the indentations in the foil.

A similar apparatus shown in Fig. 54 within a case is connected to the movable lips of a mask, so that these lips open and close as in articulation, at the same time that the sound vibrations are given by the phonogram to the phonet.

Fig. 56 represents a toy phonet in which the phonogram strip 35 is secured at one end to a cylinder upon which it is wound. By pulling upon the strip it is unwound, and a rubber cord 37 is wound upon the shaft of the cylinder. When the hand is removed from the indented strip, the rubber cord rotates the shaft and winds up the phonogram upon the cylinder, and the sounds are reproduced in the phonet by the phonogram acting upon a point and diaphragm a. The movement of the shaft is regulated by the fan, worm, and pinion 38.

In Fig. 57, the cylinder for moving the phonogram strip is shown as provided with pins that enter holes in the edges of the strip; this causes the strip to be fed along very regular.

In Fig. 58, the cylinder with pins is shown as made with heads to act as guides for the strip.

Fig. 59 shows a re-indenting device for amplifying or increasing the size of the indentations. There are two rollers, one of which a^3 travels faster than the other a^2, and there is a lever 40 pivoted at 41, and provided with a point c for each cylinder. One point follows the indentations in the cylinder a^2, and the other rests upon a^3, and as this travels the fastest, the indentations made therein will be longer and also deeper by the point being at the outer end of the lever.

In Fig. 60, one roller 42 of the pair is made of hardened metal with the sound record in relief. This is obtained by electrotype or other process from an iron foil or other metal phonogram, and this roller is used to indent strips or sheets of foil or rollers to produce copies that can be used with the phonet.

Fig. 61 represents a roller 42 of hardened metal with the record in relief, and arranged so as to knurl or indent the phonogram in a roller 43 of soft metal that is to be pressed against the roller 42 by a screw or other suitable means.

The cylinder having a spiral groove in its surface may be made by placing the mould shown in Fig. 62 around a cylinder or shaft, and filling the space between

the cylinder and mold with plaster of Paris or other suitable material. The mold is of metal with a screw or spiral rib projecting therefrom, and it is made in two parts and hinged so that it can easily be removed when the plaster of Paris is dry.

For amusement or instruction, the phonograph is capable of extended use; for instance, a revolving cylinder, see Fig. 63, containing rows of indentations representing the letters of the alphabet, and provided with keys containing corresponding letters, can be used in teaching the alphabet, and sentences, speeches, and other matter can be spoken by the phonet, and repeated by the learner without the eyesight being called into use.

Clocks may be provided with phonogram cylinders or wheels to call off the hours, to give alarms, &c.

The phonogram may be upon a strip, sheet, belt, or roller, and it can be of a dog's bark, a rooster's crow, a bird's song, a horse's neigh, and these can be used in toy animals with a simple phonet for reproducing the sound.

In copying phonograms, or making duplicates, an original phonogram may receive a deposit of copper or iron in a plating bath; and, if of iron, may be carbonized to convert it into steel and hardened, and then the same should be backed up with type metal, and used for impressing strips or pieces of metal.

A bed of gutta percha, or similar material, may be used to sustain the sheet metal while being pressed. Numerous copies of the original phonogram can thus be reproduced.

A plaster cast can be used for producing a copy by pressure.

The governor to regulate the speed of the instrument may be made of a pendulum weight 61, see Fig. 64, hung at the lower end of a rod that is provided with a universal joint at 62, and the upper end of the rod is moved around by a crank 63 that is revolved by the train of gearing. As the speed increases the weight will describe a circle of larger diameter, and thereby increase the resistance.

The universal joint may be displaced by a spring wire, Fig. 65, that allows of the movement.

A magnet 64 upon the crank arm 63, Fig. 66, may be used to revolve the pendulum by attracting an armature at the upper end of the pendulum rod, and thereby avoid the friction resulting from the contact of the surfaces of the pendulum rod with the crank.

In Fig. 67 the diaphragm b is represented as connected to a pair of delicate piston valves within a tube 68 that has three ports; one, 69, is connected to a reservoir of compressed air, the others, 70 and 71, are connected to a chamber 72 at opposite sides of a diaphragm, so as to vibrate the same in harmony with the diaphragm b, but there will be greater amplitude given to the same by the pressure of the air, and by a connection to the phonet diaphragm b^3 the sound produced will be greatly increased.

What I claim as my Invention is,—

First. The combination with the diaphragm and point of a flat receiving surface and means for revolving the receiving surface, and causing the point to follow a volute or spiral line, substantially as represented in Figs. 1, 2, 6, 7, 8, 9, 10, and 34.

Second. The combination with the revolving plate phonograph or phonet of a propelling weight or spring and a governor to regulate the speed, and ensure uniformity of movement, substantially as set forth.

Third. A revolving disk provided with a clamping frame to secure the foil or other material in combination with the swinging arm, diaphragm, and point, substantially as specified.

Fourth. In a phonograph or phonet, a spring introduced between the diaphragm and the point, substantially as set forth and shown in Figs. 16, 17, 18, 19, 22, and 26.

Fifth. In a phonograph or phonet a rubber spring, or similar device, to dampen

the vibration of the diaphragm, and prevent false vibrations, as set forth and shown in Figs. 16 and 21.

Sixth. The combination with the diaphragm in a phonograph or phonet apparatus of a lever to modify the relative action of the diaphragm and point, substantially as described, and shown in Figs. 17, 18, 27.

Seventh. The combination with the diaphragm and point of a permanent or electro-magnet, substantially as described, and represented in Figs. 24, 25, 26.

Eighth. The method of recording and reproducing two or more sounds or speeches simultaneously, substantially as described, and as illustrated by Figs. 28, 29, and 48.

Ninth. A phonet composed of a perforated sirene and a jet tube, substantially as described, and represented in Fig. 30.

Tenth. The mechanism for producing a phonogram, and employing the same in a phonet, substantially as described, and illustrated in Figs. 32, 33, 35, 36, and 37.

Eleventh. The combination with the phonograph, diaphragm, and point of a sound chamber, substantially as described, and illustrated in Figs. 31, 38, 39, and 53.

Twelfth. The diaphragm and mouth-pieces for speaking phonograph, substantially as described, and as illustrated in Figs. 41, 42, 43, 44, 45, and 46.

Thirteenth. The combination with a diaphragm and its point of two diaphragms for the purposes, and substantially as shown in Fig. 49.

Fourteenth. The combination with a diaphragm and valve actuated by sound vibrations a source of compressed fluid and a trumpet, as in Figs. 51, 52, or a phonograph as in Fig. 50, substantially as set forth.

Fifteenth. The combination of two diaphragms with a valve and a source of compressed fluid, as represented in Fig. 67, for increasing the volume of the voice or other sound, as set forth.

Sixteenth. The combination with two or more phonograms of phonet keys for selecting letters or utterances as described, and illustrated in Fig. 63.

Seventeenth. The means for duplicating or reproducing phonograms from an original phonogram, substantially as set forth.

Eighteenth. The combination with the phonograph or phonet of the revolving crank and pendulum governor, substantially as described, and shown in Figs. 64, 65, 66.

Nineteenth. The combination with the phonograph of a lever moved by the lips, and of a lever and phonet to move the lips of a mask, substantially as described, and illustrated by Figs. 55 and 54.

Twentieth. The combination with a phonogram of a clock movement or toy and a phonet for reproducing sounds for clocks or toys, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 17th day of September, A.D. 1878.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMYTH,
76, Chambers St., New York,
HAROLD SERRELL, 76, Chambers St., New York.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
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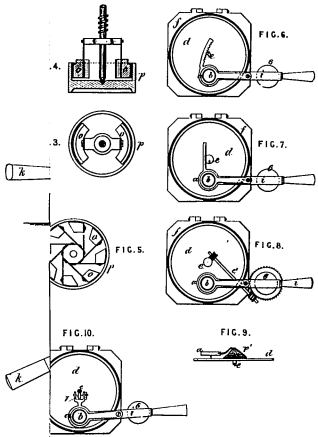
For Her Majesty's Stationery Office.
1878.

A.D. 1878. APRIL 24.
EDISON'S SPECIF

(4 SHEETS)
SHEET 1



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A.D. 1878. April 24. N° 1644.
EDISON'S Specification.

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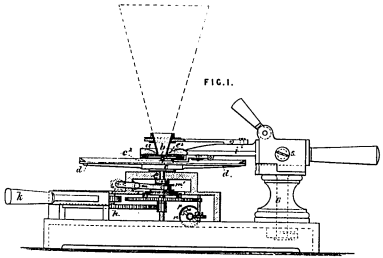
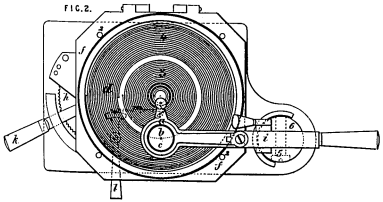
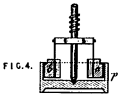
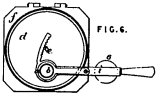
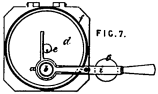
SHEET 1

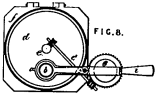


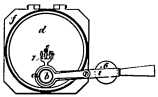












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A.D.1878. April 24. No. 1644.
EDISON'S Specification.

(4 SHEETS)
SHEET 2.

FIG. 11.

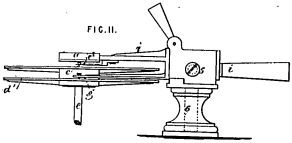


FIG. 12.

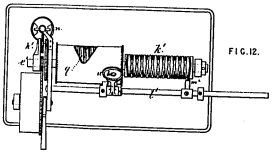


FIG. 13.

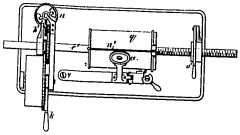


FIG. 14.

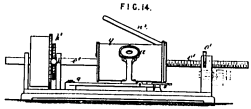


FIG. 15.

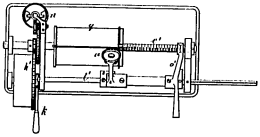


FIG. 16.

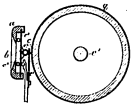
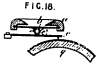


FIG. 17.

FIG. 18.



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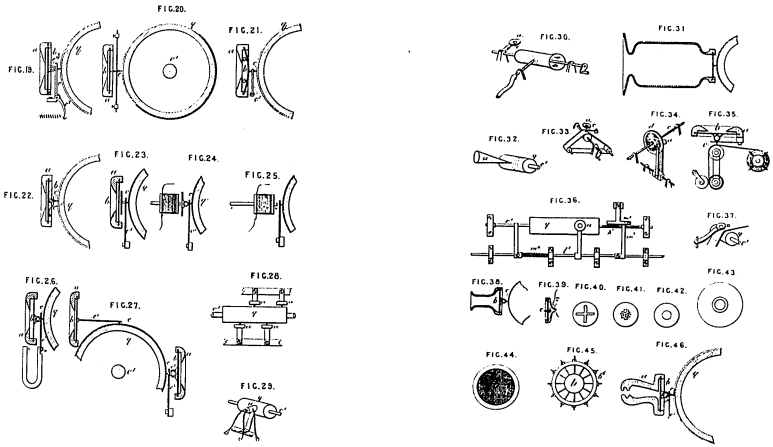

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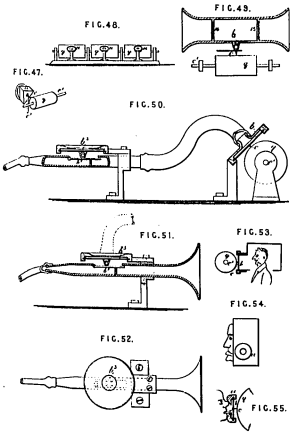

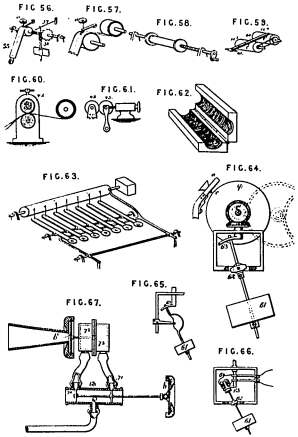

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[Second Edition.]

A.D. 1878, 15th *June*. N° 2396.

Telephones and Apparatus Employed in Electric Circuits.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN TELEPHONES AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 15th June 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America, "IMPROVEMENTS IN TELEPHONES AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

In this apparatus I make use of a plate or body against which the sound waves in the atmosphere act, and connected therewith is a button or buttons of carbon or other semi-conducting material placed in the electric circuit. The pressure due to the impact of the sound waves acts on the carbon, and produces the rise and fall of electric tension in the circuit.

The circuits are arranged to bring into action one or more primary and secondary currents, and an induction coil or coils, and switches and a call, so that signals can be sent and messages transmitted in opposite directions over one line. The receiving instrument is provided with an electro-magnet and an armature formed of an iron plate diaphragm, and a hammer is attracted or repelled so as to strike upon the diaphragm to form a call, and a stand is used to keep the telephone instruments in proper position for the call to act.

Two or more vibrating instruments connected in the same circuit, and operated by electro-magnets are thrown out of the circuit by a shunt, and act to give signals in two distant instruments provided with diaphragms. I employ a condenser in the local or main line circuit to neutralize the static charge or discharge, which condenser is preferably made of two strips of foil wound into a spiral form, with non-conducting material intervening, and to which strips the respective circuit wires are connected.

The carbon employed in the circuit is preferably the finest quality of selected lamp-black, consolidated by heavy pressure, but plumbago and various forms of carbon or iodide of copper, black oxide of manganese, finely divided metals,

[Price 10d.]

peroxide of lead, or similar semi-conducting materials reduced to a powder and moulded in buttons or discs may be employed.

The induction coils serve to throw into the line a powerful induced current, and, in some instances, I employ a battery connected with the line, and balanced so that the sound waves acting on the carbon or other resistance, cause either the positive or negative of the battery to preponderate on the line. The condenser introduced in the same circuit gives both static and induction currents. Fine wires may take the place of the strips of foil in the condensers.

Where the air waves strike upon a vibrating plate or disc, the change of pressure upon the carbon may be obtained from a thin strata of air intervening between the diaphragm and the platina plate of the carbon.

A magneto-electric machine is sometimes used as the source of electric energy in place of a battery, and the telephone instrument placed in the Wheatstone bridge, and place resistances to balance the electric forces, so that variation of the resistance in the telephone sends the current on the line.

Telephones in local circuits or shunts at way stations, with induction coils in the main line, are used for operating local telephones on the main line.

The sound vibrations act by leverage upon the carbon or other resistance, to increase or lessen the motion as circumstances require.

A secondary battery in some cases is employed in place of a condenser, and a thermal battery can be employed as the source of electric energy.

Where the electric current is made to pass through water or an electrolytic solution, the diaphragm acts upon a valve or cut-off to vary the volume of liquid where the current passes, and effect a rise and fall of electric tension.

A Daluce dry pile is combined with a diaphragm at each terminal for transmitting and receiving sound.

An electrophorous similarly combined is sometimes employed for the same purpose.

Calls are combined with the telephone so as to attract attention to the instrument.

These calls are operated by pendulums, forks, or reeds, which set up magneto-electric currents when vibrated, and from these the bell or other call receives its movement from the distant station.

The receiving portions of the telephone are of a character adapted to respond to the electric pulsations from the transmitting telephones aforesaid.

Sometimes there are two or more receiving diaphragms to one air chamber to augment the sound.

It is important to use a damper upon the diaphragm to prevent false vibrations.

Mercury globules receiving motion from the electric action are sometimes employed to actuate the receiving diaphragm, and the magnet of the receiving diaphragm is polarized with a local battery and double coils.

A diaphragm connected directly upon the induction coil will respond to the electric waves and give audible sounds.

In place of flexible wires for the telephone connections, wires with universal joints are preferable.

Long funnels are used with the telephonic receiver to increase the volume of sound.

The expansion or contraction of gases and other materials by change of temperature or hygrometic condition are employed to vary pressure upon the carbon button or disc between its two platina armatures, and a galvanometer in the circuit by its movement indicates with the greatest and most absolutely certain accuracy the extent of the disturbing cause that is exerted on the carbon.

The galvanometer may be wound differentially or placed in a Wheatstone bridge.

Induction coils are made of forms specially adapted to the telephone apparatus, and the condensers are sometimes connected in a continuous metallic circuit.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 13th December 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN TELEPHONES AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

In this apparatus I make use of a plate or body against which the sound waves in the atmosphere act, and connected therewith is a button or buttons of carbon or other semi-conducting material placed in the electric circuit. The pressure due to the impact of the sound waves acts on the carbon, and produces the rise and fall of electric tension in the circuit.

Fig. 1 is a vertical section of the transmitting instrument, and Fig. 2 is a plan of a portion of the same.

The body of the instrument is made of the two shells *a* and *b*, between which the diaphragm *c* is clamped at its edge, and said diaphragm receives the impact of the sound waves which enter through the opening or mouth-piece b^1. *e* is a disk of insulating material secured to the screw *f*, and in a cavity in this disk is the carbon button *h* between the platina disks 1 and 2; the disk 2 is secured to the screw *f*, and the disk 1 is connected to the metallic ring 3 by a strip of platina at 4, in order that said disk 1 may be free to move.

The disk 1 is connected to the wire 5, and the disk 2 to the wire 6.

Upon the diaphragm *c* there is a short tube *i* that rests upon the disk 1. As said diaphragm receives the impact of the sound waves, the carbon button is subjected to different pressures, and varies the resistance to the passage of the electric current through the same, consequently, the current passing in the circuit is varied in its electric tension; this current acts in the distant receiver as hereafter explained, to give movement to a diaphragm, and produces sounds corresponding to those which are received upon the diaphragm *c*. The screw *f* allows of the carbon button and disks 1 and 2 being raised or lowered to adjust the initial pressure of the diaphragm on the carbon button.

The carbon employed for the button *h* is preferably the finest kind of selected lamp-black consolidated by heavy pressure, but plumbago, carburet of iron, gas retort carbon, or various compounds which are partial conductors in the dry state may be used, such as iodide of copper, black oxide of manganese, peroxide of lead, or similar semi-conducting materials, reduced to powder and moulded in buttons or disks; also finely divided metals, such as platinum, black gold, or disks of metal with a roughened surface having many points may be used. The circuits are arranged to bring into action one or more primary and secondary currents, and an induction coil or coils, and switches, and a call, so that signals can be sent and messages transmitted in opposite directions over one line, as illustrated in the diagram Fig. 3.

At station 1 is the carbon transmitter, and said instrument is included within the primary circuit of the induction coil D, E. D is the primary wire of the coil, and is wound on the outside of the secondary coil E. C is a switch, which, when moved to the right in contact with 15, places the transmitter A in the primary circuit containing the battery K and coil D. When the switch is in the center the primary circuit is open, and the apparatus is ready for the reception of a call signal.

When the switch is turned to the left at 16 the instrument A is thrown out of circuit, and the battery only is connected to the primary coil D. The movement of the switch from 16 several times serves to open and close the primary circuit, and throw a powerful induced current into E, and then to the line. The polarized relay F, coil E, and receiving instrument B, are all placed in the main line wire at both stations. The powerful current thrown into the secondary coil and line by the movement of the switch C from 16 works the tongues of both polarized relays F

in unison with the switch, the tongues closing against their contact points close a local circuit containing a call bell H.

The same battery K that is employed with the telephones is utilized to ring the bell. The connections for the transmitter A are from the battery K by wire 20 to 21, then through the telephone A to wire 22, and from 22 to 15, through the switch lever C to the primary coil D, and to wire 23, back to battery. This is the connection for transmitting and receiving telephonically. When not thus working the switch C is placed in the central position between 15 and 16. When in this position, if the switch of the distant station is moved to operate the call, the tongue of F closes the local circuit at *g*, thence by wire 24 to battery K, and through K to wire 25, thence through the magnets of the bell call to wire 26, and then through the tongue of the polarized relay. When the switch C is moved to work the distant call it is brought into contact with 16, and the current passes from K by wire 20 to 16, thence through C to the primary wire D, thence to 23, back to the battery K, and setting up a powerful induced current in the coil E and line. I will mention that it is not necessary to use a polarized relay, as an unpolarized relay of the ordinary character may be used as the current due to the opening of the primary circuit is much the strongest, but the lever of the unpolarized relay should be light and the spools very short. It is not even necessary to use the call bell H in many instances when the terminal is very quiet, as the sound 20 given by the polarized relay itself is sufficient, or a small bell may be worked by the tongue of the relay itself. The tongue of the polarized relay should be biased, so that it will always be away from the point *g*, except when moved by the signalling currents, so as to prevent short circuiting the battery K when transmitting telephonically. By employing two cells and a considerable resistance in the magnets 25 upon the call bell, it is not essential to bias the tongue, but it may be made to respond to both positive and negative, a shunt from one cell being used to furnish current to the call bell. The receiving instrument is provided with an electromagnet, and an armature formed of an iron plate diaphragm, and a hammer is attracted or repelled, so as to strike upon the diaphragm to form a call, and a stand 30 is used to keep the telephone instruments in proper position for the call to act; these devices are shown in Fig. 4. A is the receiving instrument, provided with a diaphragm and a magnet for giving motion to it, the same as shown in British Letters Patent No. 2909, of 1877, granted to me. The magnet of the receiving instrument is included in the main line *a*, *a*, *a*; C is the primary coil; D, the 35 secondary coil, which latter is included in the main line circuit; *e* is the sounder lever resting upon the diaphragm of A; X is a rack or stand for holding both the receiving and transmitting instruments when not in use. S is a switch; when it is turned to the point 1, the transmitter B is included in the primary circuit with coil C and battery Q, and the transmitter serves to increase and decrease its 40 resistance when the diaphragm is vibrated by sound.

The transmitter is provided with a carbon button, through which the current passes, and it produces more or less resistance, according to the strength of the sound waves impinging on the diaphragm, as before described. When the switch lever S is moved to the point 2 the secondary wire of the coil is short circuited; 45 it remains in this position for the reception of a call signal from the distant station; were the coil D left in circuit it would tend to weaken the signal call by its resistance to the passage of the current from the distant station. When the switch lever is at the point 3, the current from the battery Q passes only through the primary wire; by connecting and disconnecting the switch S from the button 3 50 powerful induction waves are thrown into the line, and act upon the distant receiver to attract and repell the lever *e*, and give the signal call. The induction coil C, D, may be made as in Fig. 5, in which the large wire C forms the primary coil, and the fine wire D wound around the same forms the secondary coil, the latter being placed in the main circuit, and the former in the local circuit, as heretofore 55 explained.

Two or more vibrating instruments connected in the same circuit and operated

by electro-magnets are thrown out of the circuit by a shunt, and act to give signals in two distant instruments provided with diaphragms. This arrangement is shown in Fig. 6, in which the connections at one end of the line are represented. Fig. 7 is a section of the resonant tube.

F and G are the vibrating reeds kept in continuous vibration by the electromagnets R and S in a local circuit, provided with a suitable contact spring operated by the reed in the usual manner, but which are not shown here for clearness. M and N are electrolytic cells arranged and operated similar to those shown in aforesaid Patent. No. 2909. The armatures of the electro-magnets are harmonic 10 reeds. The vibration of one of the electrodes serves to increase and decrease the resistance of the electric current by causing the current to pass through a greater or less amount of water between the electrodes. L is the main battery in the main line T, in which are the cells M, N. H and K are keys used for the purpose of stopping and starting the waves over the wire, which they accomplish by short 15 circuiting the electrolytic cells N or M. The reeds F and G are tuned to give different tones, and several reeds, substantially the same as herein described, may be included in the same circuit, all being toned differently. A and B are the receivers which are shown as resonant tubes. Upon the ends of the resonant tubes are iron or steel diaphragms, which act as the armatures of the electro-magnets 20 E, E', which are facing them. X and X' are secondary tubes which slide within the tubes A & B like the tubes of a telescope. The object of the tubes is to allow of the lengthening or shortening of the column of air in the resonant tube, so as to bring it in unison to the particular note or tone which it is desired to hear. The iron diaphragm responds to all the tones with equal power, and were not some 25 means provided for strengthening or reinforcing one particular tone it would be very difficult for the operator to pick out the tone required, but by the use of the resonant tubes this difficulty is overcome, because the tone is given distinct when the armature is vibrated in harmony with the note of the tube.

The induction coils serve to throw into the line a powerful induced current, and 30 in some instances I employ a battery connected with the line, and balanced so that the sound waves acting on the carbon or other resistance cause either the positive or negative of the battery to preponderate on the line. The induction coils and their arrangement in the electric circuits are shown in Figs. 9, 10, 11, and 12. In Fig. 9 the transmitter is provided with the diaphragm *c* and carbon button *h*, as 35 before described. 1, 2, and 3 are induction coils having their primary coils wound on the outside, and all connected in the same circuit, in which also is included the disks 1, 2, carbon button *h*, and local battery B. The secondary or inner coils of 1, 2, and 3 are all connected together and are included in the main line circuit with the receiver and call bell. The impact of the sound waves upon the diaphragm *c* 40 subjects the carbon button to more or less pressure, according to their strength; hence the resistance of the circuit will be varied owing to the small resistance of the local circuit and the power of the battery; a very slight change in the resistance of the circuit throws a powerful induction current into the secondary coils, which passing over the line sets the distant receiver in vibration corre- 45 sponding to the air vibrations striking the diaphragm of the transmitter. The object of using more than one induction coil is to get a greater amount of wire nearer the iron cores, which are bundles of iron wire. In Fig. 10, the same kinds of coils are shown, but they are connected in the local circuit slightly different, being connected in derived circuits, or for quantity. In Fig. 11, but one secondary 50 coil is used, the primary circuit being divided into several coils, arranged for quantity. This brings more current from the battery, and a very slight change in the resistance in the carbon button of the transmitter causes a powerful induced current to circulate in the secondary coil and line. In Fig. 12 is shown another method of arranging the local batteries so that when the diaphragm of the 55 transmitter is in its normal position its resistance is equal to R when no current passes in the primary coil of the inductorium, but the slightest change in the resistance of the carbon button *h* destroys the balance between the batteries, and a

current passes to the primary. In Fig. 8, a condensing induction coil is shown. The coil 1 is formed of two long strips of metallic foil presenting a large surface to each other; the strips are wound into a spiral with non-conducting material intervening, and to these strips the respective circuit wires are connected. The current passes from end to end. One coil of foil is connected in the main line circuit and forms part of it, while the other is connected in the local circuit with the battery and carbon transmitter. The induction coils and circuits are sometimes arranged as in Fig. 15.

At station A the transmitter A is provided with the carbon button and disks afore-mentioned. B is the receiver, provided with an iron diaphragm opposite the core of an electro-magnet, the same as in aforesaid Letters Patent, but an ear tube at the end of a flexible tube connected to the body of the receiver is shown at b^2. The transmitter A is included within the primary circuit of an induction coil G. C is a switch which when moved to the right in contact with D places transmitter A in said primary circuit containing battery F and coil G. It also allows the line current to pass through receiver B, secondary coil H, switch point C, and transmitter A to ground. When the switch is placed to the left in contact with E the instrument A is not in circuit, and the receiver B and coil H are short circuited, so that the line is completed through the calling sounder J, switch point E, primary coil G, battery F, to the ground.

The batteries are so arranged at each end of the line that when both switches are placed to left on E they will act together instead of against each other, there being sufficient battery to work the calling sounders at each end of the line. At station B the calling sounder is replaced by a relay J^1; this device I use when the line is too long for the sounder to operate distinctly, or when the call bell K, which is worked by points of relay J^1, is required to be placed at a distance from the other instruments. The bell K is placed in a local circuit with battery L.

Sometimes I employ a battery connected with the line and balanced so that the sound waves acting on the carbon or other resistance cause either the positive or negative of the battery to preponderate on the line. In Fig. 14 the polarity of the iron core of the induction coil D, E, is reversed at every vibration of the diaphragm c; h, h^1, are two carbon buttons, and the disks 1 and 2 are connected forward h^1 sends a current in one direction, and when it goes backward h sends a current in the contrary direction.

When the air waves strike upon a vibrating plate or disk the change of pressure upon the carbon may be obtained from a thin strata of air intervening between the diaphragm and the platina plate of the carbon. Fig. 15 shows a transmitter and the carbon button h and disks 1, 2, arranged so that the pressure on the carbon is obtained by the movement of the air between the diaphragm c and disk 1 as said diaphragm is vibrated.

A magneto-electric machine is sometimes used as the source of electric energy in place of a battery, and the telephone instrument placed in the Wheatstone bridge and resistances placed to balance the electric forces so that variation in the resistance in the telephone sends the current on the line. Fig. 16 represents the transmitting instrument sectionally, and also shows the circuit connections with the telephone in the Wheatstone bridge.

The transmitting instrument A contains the mouth-piece b and a diaphragm c secured at its edges. The centre of the diaphragm is platinized, and upon this rests the button h of carbon. The metallic disk 2 is kept in contact with the button by the rod and spring a, and d is an adjusting screw to regulate the pressure of the plate 2 upon the carbon button h. Said screw passes through the metallic support that is secured to the vulcanite ring g around the button. The diaphragm is connected to the wire 4 and the plate 2 to the wire 5. Any atmospheric vibrations similar button h in the electric circuit in consequence of the difference in pressure upon such carbon button, resulting from the momentum of the parts and the inertia

of the plate d. The transmitter is in one branch of the Wheatstone bridge; R^3 is a resistance equal to that of A when not subjected to sonorous vibrations; R^1, R^2, form the other sides of the balance, and have equal resistances. The bridge wire from M to N is contained in the telegraphic circuit that extends from N by the line wire to the distant receiver H, thence to the earth, and returning to the earth plate at the distant station and to M. The battery B of several cells is between 5 and R^1, R^2. When the resistance of A, R^1, is equal to that of R^2, R^3, no current circulates upon the line. When sonorous vibrations vary the resistance of the carbon button h in A the current will pass upon the line in one direction or the other. When the resistance of A is increased the current passes in one direction. When it is lessened the current passes in the other direction in consequence of the balance being disturbed.

The induction coil H has its secondary coil included in the line circuit, and the primary coil is connected with a transmitting instrument T constructed and operating in a similar manner to the transmitter A, the local battery B^1 being in the circuit through the carbon button and primary coil. The receiving instrument L is provided with a diaphragm that is acted upon by the core of the induction coil H, and hence the induction coil is utilized and serves for receiving or transmitting telephonically. In Fig. 17 the balance of the similar batteries B, B^1, with opposite poles to line is obtained by the rheostat R^3 that is of a resistance equal to that of the instrument A when at rest, and when the resistance of the carbon button in A is increased or decreased by the sonorous vibrations the current will pass upon the line either positive or negative, according to the resistance in A. In Fig. 18 a modification of the transmitter is shown. The plate c rests against a disk of fibrous substance c^3, such as silk, with a finely divided material such as plumbago worked into its fibers. There may be several such disks, and the plate 2 is at the opposite side of these disks. There are edges that are turned over to receive the edges of the mouth-piece b, and a spring e presses the plate c towards the disks of silk so as to hold them against 2. One conductor from an induction coil passes to 2 and the other to c, and the slightest sonorous waves acting against c varies the resistance according to the pressure upon the fibrous material. Telephones in local circuits or shunts at way stations with induction coils in the main line are used for operating local telephones on the main line, as shown in Fig. 19.

A^2 and B^2 are magnets placed at way stations; A^1, A^2, are carbon transmitters, which serve to short circuit the magnets more or less, according to the vibrations of the diaphragms of said transmitters.

The sound vibrations act by leverage upon the carbon or other resistance to increase or lessen the motion as circumstances require. In Fig. 20 the carbon h is acted upon by the lever X upon the fulcrum x, and said button is placed between the fulcrum of said lever and the point where the lever is acted upon by the diaphragm of the transmitter. In Fig. 21 the carbon button is acted upon by the outer end of the lever X.

In Fig. 22 the carbon button h is secured to the outer end of the lever X, and said button rests upon a button of carbon x^1 secured to the diaphragm c of the transmitter.

The lever is weighted at a^4, and there is a spring at a^5 and adjusting rod by which the initial pressure of the carbon button h upon the button x^1 may be adjusted. There is a plate b^3 of mica or other light material secured to the lever X, and upon this plate the sound waves strike. The transmitter is shown as upon a resonant box c^4 with an opening in the top of the box immediately beneath the diaphragm c. The slightest vibration or jar given to the apparatus, such as that resulting from walking about a room, or from the articulate speech or sound vibrations, vary the pressure of h and x^1 upon each other, and in so doing the electric condition of a circuit passing through X, h, x^1, and c, and wires 7 and 8 is varied, and a corresponding response occurs in a distant receiving telephone.

A secondary battery is sometimes employed in place of condenser, as in Fig. 23;

this is used with a Walloston electrode. This arrangement allows the first part of a wave to be strong, followed by a weakening, due to resistance placed in circuit by polarization of the small point. This extra resistance allows more current to pass to secondary coil. A thermal battery similar to that shown in my Letters Patent aforesaid may be used as the source of electric energy.

When the electric current is made to pass through water or an electrolytic solution the diaphragm acts upon a valve or cut-off to vary the volume of liquid where the current passes, and effect a rise and fall of electric tension.

Fig. 24 is a vertical longitudinal section of a transmitter fitted with this improvement; and Fig. 25 is a cross section at the line *x*, *x*.

B is a cylinder of insulating material divided by a partition b^1 into two compartments or cells filled with a conducting fluid. In each cell is an electrode of platina, carbon, or other conductor, one of which is connected to the line wire, and the other to the battery and earth. The top portion of the partition b^1 is slightly hollow, leaving a passageway 2 for the fluid and current to circulate from one cell to the next. Resting upon the face of the cylinder is a flexible head of mica, rubber, or other non-conducting material *c* impervious to the fluid, and over this is a secured a cap *c* provided with a slot. When the cap *c* is securely fastened to the cylinder the diaphragm prevents any of the fluid circulating from one cell to the other, except through the small aperture at 2 made by the curve on the end of the partition b^1. *b* is a box with a mouth-piece A, and at one side of the box is secured the diaphragm *i*, and upon the diaphragm is a piece of cork *t*, which extends outward from the slot in the cap *c* on the head of the cylinder B, and comes in contact with the mica or rubber flexible head *c*, to which it may be secured by a cement, although this is not actually necessary. The operation is as follows:—When the diaphragm *i* is properly adjusted to the diaphragm in the cylinder B, the space for the circulation of the fluid from one cell to the other is very narrow. If, now, the diaphragm is set in vibration by a sound, the passage-way is increased and decreased in size at every vibration, thus increasing and decreasing the resistance to the passage of the current from one cell to the other, owing to the alteration in the size of the liquid conductor. If the amplitude of the diaphragm is very great, the space is nearly, if not altogether, closed at the forward movement, and widened to its fullest extent by the backward motion; and if the amplitude is small only a slight increase and decrease in size of the aperture take place, according to the size of the opening, so there will be more or less resistance to the current passing through the liquid at this point, and there will be a corresponding rise and fall of electric tension on the line at this point. It is obvious that with a mobile fluid all the harmonical and other sounds incident to articulation act to produce corresponding changes of electric tension. In Fig. 30 the cylinder B is represented as standing vertically instead of horizontally, as in Fig. 24, which permits of the diaphragms *c* and *c* being dispensed with. In Fig. 26 I have represented several narrow slits in the partition b^1 between the cells, and a thin strip of metal i^2, from the diaphragm *i*, running down at the side of the partition, and also slotted, but the slots in the normal position do not correspond; hence, by the vibration of the diaphragm, the openings are increased or lessened, and the resistance to the electric current increased or decreased.

Fig. 27 shows the partition b^1 arranged horizontally, the passage way from one cell to the other being controlled by a valve or plunger *l*, arranged at an aperture through the partition. In Fig. 28 the passage way is between two independent cells by means of a flexible tube *m*, and the opening is increased or lessened by the movement of the diaphragm acting through a finger *n* that presses upon the flexible tube. I will mention that mercury may be used instead of an electrolyte, or a porous material, such as paper, may serve to connect the cells together. *s* represents a piece of porous material, such as paper or muslin, and the ends pass into liquid in the cells, so as to be kept moist by capillary attraction; and adjacent to this is a presser *p*, connected to the diaphragm or other vibrating body, so as to

be moved by the same, and press with more or less force upon the moistened strip, and interrupt the passage of electricity more or less, according to the amplitude of vibration.

A Duluce dry pile is combined with a diaphragm at each terminal for transmitting and receiving sound; this is shown in Fig. 31. D is a tube containing a Duluce dry pile of many pairs; one end is connected to earth, the other to a disk d^2, facing a metallic diaphragm *c* connected to the line and distant station, where it connects to a precisely similar apparatus. The movement of the diaphragm to and from the disk causes a rise and fall of electric tension on the line.

An electropherous, similarly combined, is sometimes employed for the same purpose, as in Fig. 32. The base 1 of metal is connected to earth. Upon said disk there is a disk of sulphur 2, charged with electricity that faces the metallic diaphragm *c*, which latter is connected to the line. The rise and fall of tension on the line is produced by the movement of the diaphragm to and from the sulphur disk.

Calls are combined with the telephone, so as to attract attention to the instrument. These calls are operated by pendulums, forks, or reeds, which set up magneto-electric currents when vibrated, and from these a bell or call receives its movement from the distant station.

In Fig. 33 the tuning fork X is vibrated by the electro-magnet x^1, by waves set in motion by a similar fork at the distant station; when the fork has received considerable vibration it strikes the lever x^2, which latter releases a clock movement that gives the alarm.

In Fig. 34 the fork X strikes the bell and gives the alarm. In Fig. 35 the fork X closes a local circuit, and the bell is rung by a magnet and local battery. In Fig. 36 a polarized relay is used with its tongue centered by a tightly drawn wire. This tongue closes the local circuit containing a magneto call-bell. In Fig. 37 two magneto pendulums X serve to give the call; the signaller lowers his bell and gives the pendulum a large swing by hand, which soon sets the pendulum in motion at the distant station by the currents which it sets up in the magnets n, n^1, which are polarized.

The receiving portions of the telephone are of a character adapted to respond to the electric pulsations from the transmitting telephones aforesaid. Sometimes there are two or more receiving diaphragms to one air chamber to augment the sound.

Fig. 38 shows a receiver provided with two metallic diaphragms *d* and two electro-magnets d^1 through which the line current passes. Fig. 39 shows the armature diaphragms *d* arranged edgeways to the opening in the mouth-piece, with magnets opposite said diaphragms. This arrangement permits of the reception of signals, but prevents the transmission of any by magneto induction. Fig. 40 shows several electro-magnets, each provided with a diaphragm, all included in one case, and all in the main line circuit; the sounds received are augmented.

Dampers may be employed upon the diaphragm of the receiving and transmitting instruments to prevent false vibrations. These may be the same as those shown and described in my British Letters Patent, No. 1644 of 1878.

A diaphragm connected directly upon the induction coil will respond to the electric waves, and give audible sounds. This device is shown in Fig. 41.

In place of flexible wires for the telephone connections, wires with universal joints are preferable. Long funnels may be used with the telephonic receiver to increase the volume of sound.

The expansion or contraction of gases and other materials, by change of temperature or hygrometric condition, are employed to vary pressure upon the carbon button or disk, between its two platina armatures, and a galvanometer in the circuit by its movement indicates with the greatest and most absolute accuracy the extent of the disturbing cause that is exerted on the carbon. In Fig. 42 is shown an instrument for measuring minute qualities of heat. *h* is the carbon

button, and 1, 2, the platina disks connected to the battery B and galvanometer G. M is a strip of vulcanite or other material that expands by heat. X is an adjusting screw which serves to force M against the disk and carbon, and bring sufficient pressure upon the carbon to deflect the galvanometer to the point where the carbon button is most sensitive to a slight pressure. When in a state of rest the heat of the hand acting upon M will expand it, and the elongation causes the pressure upon the carbon button to be increased, hence more current will pass through it, and the galvanometer needle will be deflected. In Fig. 43 is shown a mercurial barometer with a float at b^1 to act upon the carbon button. The galvanometer G may be wound differentially or placed in a Wheatstone bridge, the button being placed in one side of the balance.

In Fig. 44 the diaphragm at 12 is provided with a pin valve that allows the compressed air or other fluid in the pipe 13 to pass to the pipe 14 and diaphragm 15. This diaphragm 15 is of iron and faces the core of a polarized magnet, and it receives more movement from the compressed air than it would if acted upon by the voice alone. The diaphragm 15 vibrates in harmony with the diaphragm 12, when the latter is vibrated by the sound vibrations of the human voice or otherwise.

In Fig. 45 the diaphragm d and mouth-piece is at the side of a closed box. Within this box there is a continuously rotating cylinder of chalk d^2, on the surface of which rests the end of a spring arm d^3 secured to the diaphragm. The chalk has combined with it an alkali or other conducting electrolyte, and is kept moist by water.

One wire is connected to the chalk cylinder and the other to the spring or diaphragm. When no current passes to the cylinder of chalk the friction of the spring upon the chalk causes the diaphragm to be drawn inward, but when an electric wave passes through such cylinder the friction between the chalk and spring is destroyed and the diaphragm moves outwardly, to be again drawn inwardly when the current ceases. By this means the diaphragm d will be vibrated in harmony with the diaphragm of the distant transmitting instrument, and will reproduce the sounds that acted upon the diaphragm of the transmitter. A sponge and cell of water is placed within the box containing the chalk cylinder, which box should be air-tight. The use of a chalk cylinder is an improvement on the device shown at Fig. 3 in my British Patent No. 2909, of 1877.

Fig. 46 shows a tube containing mercury, in which is a float in water above the mercury; the float is connected to the diaphragm d. The diaphragm will be vibrated by the movement of the mercury, caused by the heat of the current passing through the same. Fig. 47 shows a transmitter made as a small mica condenser formed of disks secured to the diaphragm, and provided with an adjusting screw X for tightening the disks. The impact of the sound waves upon the diaphragm varies the capacity of the condenser and transmits corresponding waves.

What I claim as my Invention and desire to secure by Letters Patent is,—

First. An electric tension regulator made of carbon or other finely divided conducting material consolidated by pressure, substantially as and for the purposes set forth.

Second. The carbon button h between the platina disks 1 and 2 in combination with the adjusting screw f, diaphragm c, and mouth-piece, substantially as specified.

Third. The combination of transmitter A, coils D, E, switch C, polarized relay F, bell H, battery K, and circuits, arranged and operating substantially as herein set forth and as shown in Fig. 3.

Fourth. In combination with a telephone and the primary circuit of an induction coil the button of lamp-black carbon, prepared as set forth and placed in the primary circuit, substantially as and for the purposes set forth and as shown in Fig. 3.

Fifth. In combination with a receiving telephone instrument, having a diaphragm and electro-magnet, a swinging lever placed with its moving end in contact with the receiving diaphragm, and a switch or key for increasing the electric current and

operating the lever as a sounder or call upon the diaphragm, substantially as set forth and shown in Fig. 4.

Sixth. In combination with the telephone transmitter B and receiver A the induction coil C, D, battery Q, local circuit, switch S, and circuit connections, substantially as set forth and as shown in Fig. 4.

Seventh. In combination with the main line circuit and local circuit and the telephonic instrument the induction coil composed of two wires, the largest of which is surrounded by a finer insulated wire wound helically, the two being then wound into a helix to form the induction coil, substantially as shown, and described in connection with Fig. 5.

Eighth. The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for rendering audible acoustic vibrations, substantially as described, and shown in Fig. 7.

Ninth. The combination with a diaphragm vibrated by an electro-magnet of a resonant tube variable in its length, so as to adjust the column of air to the tone of the transmitting instrument, substantially as shown and described with reference to Fig. 7.

Tenth. The combination with a vibrating reed and electrolytic cells placed in the electric circuit of a key placed in a shunt circuit, substantially as shown in Fig. 6.

Eleventh. The condensing coil 1, Fig. 8, arranged in the electric circuit, and operating substantially as described.

Twelfth. The induction coils 1, 2, 3, Fig. 9, electric circuits, and carbon transmitter, arranged and operating substantially as and for the purposes set forth.

Thirteenth. The induction coils and electric circuits and carbon transmitter, arranged and operating as described, and shown in Fig. 10.

Fourteenth. Two or more primary coils wound upon one secondary coil, as in Fig. 11, in combination with the electric circuits and carbon transmitter, substantially as specified.

Fifteenth. The induction coil 1, resistance R, batteries B, electric circuits, and carbon transmitter, arranged and operating as described, and as shown in Fig. 12.

Sixteenth. The induction coils G, H, telephonic instruments A, B, switch C, key and sounder, arranged and operating in the electric circuits, substantially as described, and as shown in Fig. 13.

Seventeenth. The carbon transmitters h, h^1, and induction coil D, E, and diaphragm c, Fig. 14, in combination with the batteries B, B, and electric circuits, substantially as and for the purposes set forth.

Eighteenth. The carbon button h and disks 1, 2, in combination with the diaphragm c of the speaking tube, arranged and operating as shown in and described with reference to Fig. 15.

Nineteenth. The combination with an induction coil of a diaphragm that is acted upon by such induction coil, and gives out sonorous vibrations, substantially as described and shown in Fig. 16.

Twentieth. In combination with the balanced circuits shown in Fig. 16 a telephonic instrument included in one circuit, and acting to vary the electric condition of the line by the resistance that is controlled by the sound vibrations, substantially as set forth.

Twenty-first. A transmitting telephone containing a variable resistance in the electric circuit and a body acting by inertia, to vary the resistance in proportion to the sound vibrations, substantially as described in connection with Fig. 16.

Twenty-second. The induction coils in local circuits or shunts at way stations in combination with the telephonic instruments, also in such circuits, substantially as and for the purposes described in and as shown in Fig. 19.

Twenty-third. The carbon transmitter h, lever X, and diaphragm c, arranged as shown in Figs. 20 and 21.

Twenty-fourth. The combination with a resonant case c^1, Fig. 22, of the lever X, diaphragm c, carbons h and a^1, disk k, and circuit connections, substantially as set forth.

Edison's Impts. in Telephones and Apparatus Employed in Electric Circuits.

Twenty-fifth. The apparatus shown in Fig. 22, capable of receiving atmospheric and other vibrations, and transmitting the same electrically to a receiving telephone through a circuit wire and connections, substantially as set forth.

Twenty-sixth. The carbon transmitter in a local circuit, containing a secondary battery, in combination with the induction coil D, E, connected in the main and local circuits, as illustrated in Fig. 23.

Twenty-seventh. In an acoustic telegraph apparatus, the combination of two stationary electrodes immersed in two cells, a conducting fluid in said cells, and a fluid connection between such cells and mechanism actuated by a sound vibrated body for varying the dimensions of such liquid connection and the conductivity of the same, substantially as set forth.

Twenty-eighth. The Duluco dry pile battery, arranged in connection with the telephonic instrument, as illustrated in Fig. 31.

Twenty-ninth. The electrophorous arranged in connection with the telephonic instruments, as illustrated in Fig. 32.

Thirtieth. A telephonic call consisting of a reed or tuning fork vibrated by an electro-magnet, and acting to strike a bell, release mechanism that sounds an alarm, or open and close a local circuit in which is an alarm or call, as illustrated in Figs. 33, 34, and 35.

Thirty-first. The polarized relay in a telephonic electric circuit, and acting to open and close a local circuit in which is a magneto call bell.

Thirty-second. In a telephonic electric circuit, a pendulum vibrated by a polarized electro-magnet, and striking a call or bell, as illustrated in Fig. 37.

Thirty-third. A telephonic receiving instrument containing two or more metal diaphragms and two or more electro-magnets, as illustrated in Figs. 38, 39, and 40.

Thirty-fourth. The induction coil, Fig. 41, with its core facing the diaphragm of the telephone, substantially as and for the purposes set forth.

Thirty-fifth. The combination in an electric circuit of one or more disks or pieces of carbon or equivalent material operated upon by pressure to vary the resistance in the circuit, and indicate by a galvanometer or other scale, differences of weight, pressure, or electric condition.

Thirty-sixth. The diaphragm 12, Fig. 44, controlling a source of compressed fluid, which latter acts upon the diaphragm 15, to give greater vibration thereto than if acted upon by the voice or sound waves alone, as specified.

Thirty-seventh. In combination with the diaphragm d and arm d^1, Fig. 45, the continuously rotating cylinder of chalk moistened with a deliquescent salt, and operating substantially as described.

Thirty-eighth. The diaphragm of the telephonic instrument connected to a float in a tube containing mercury and water, said diaphragm being vibrated by the motion of the mercury, substantially as described in connection with Fig. 46.

Thirty-ninth. The telephonic transmitter, Fig. 47, made with a mica condensor, formed of discs, secured to the diaphragm, and provided with an adjusting screw for tightening the disks, as specified.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 27 of November, A.D. 1878.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 76, Chambers St., New York.
GEO. T. PINCKNEY, " " " " "

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A.D. 1878, JUNE 15. Nº 23
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(3 SHEETS)
SHEET 1.

FIG. 4.

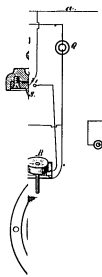


FIG. 5.

FIG. 8.

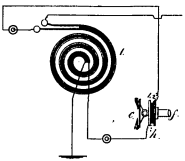
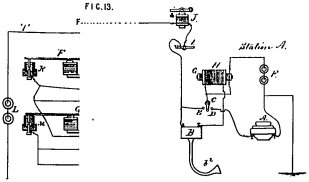


FIG. 13.



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(3 SHEETS.)
SHEET 1.

FIG. 1.

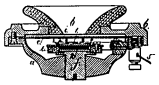


FIG. 2.

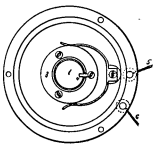


FIG. 3.

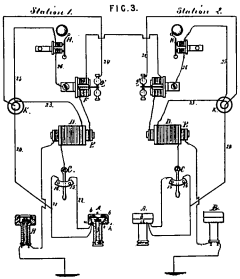


FIG. 4.

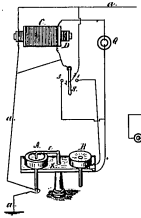


FIG. 5.

FIG. 8.

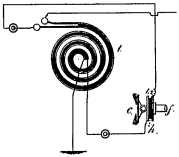


FIG. 6.

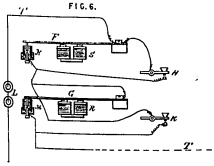


FIG. 7.

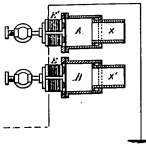
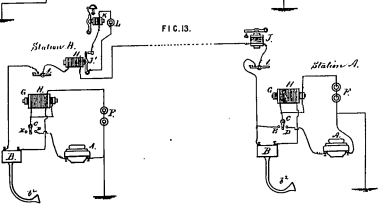
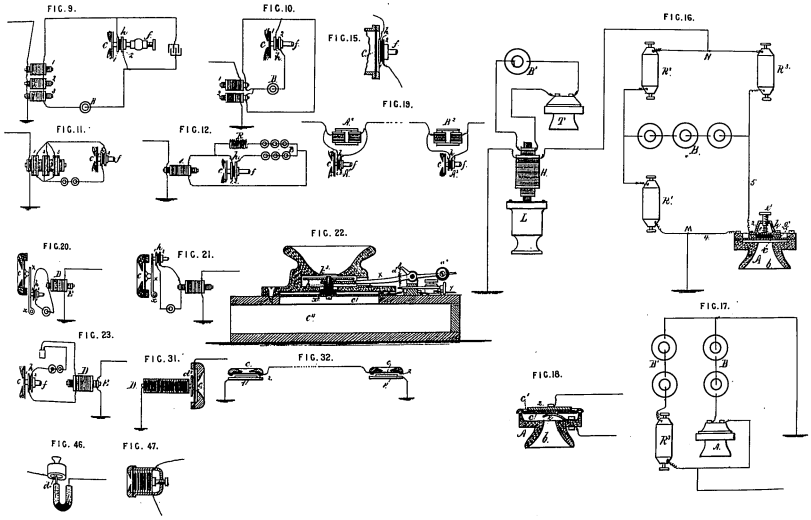


FIG. 13.



Melly & Sons, Photo-Lith.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

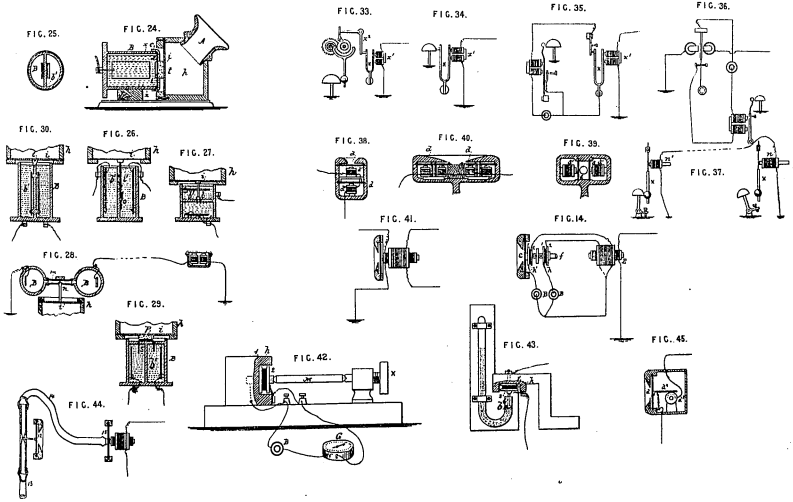


Hally & Sons, Photo-Lith.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

A.D.1878, June 15. № 2396.
EDISON'S SPECIFICATION.
(2nd Edition.)

(3 SHEETS)
SHEET 3.



Malby & Sons, Photo-Lith.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

A.D. 1878, *7th November.* N° 4502.

Lighting by Electricity.

LETTERS PATENT to Edward Griffith Brewer, of the Firm of Brewer and Jensen, of 33, Chancery Lane, in the County of Middlesex, Patent Agents, for the Invention of "IMPROVEMENTS IN LIGHTING BY ELECTRICITY." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

Sealed the 21st January 1879, and dated the 7th November 1878.

PROVISIONAL SPECIFICATION left by the said Edward Griffith Brewer at the Office of the Commissioners of Patents on the 7th November 1878.

EDWARD GRIFFITH BREWER, of the Firm of Brewer and Jensen, of 33, Chancery Lane, in the County of Middlesex, Patent Agents. "IMPROVEMENTS IN LIGHTING BY ELECTRICITY." (A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.)

According to this Invention the light giving material is employed in the form of cylinders or prisms consisting of finely divided metals, such as platinum, iridium, rathinium, or other material having a high melting point, mixed with nonconductors such as magnesium or zircon oxides that are with difficulty melted. These are mixed and compressed into the proper form for the light, and rendered luminous and incandescent by the passage of the electric current.

[Price 6d.]

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Edward Griffith Brewer in the Great Seal Patent Office on the 7th May 1879.

EDWARD GRIFFITH BREWER, of the Firm of Brewer and Jenson, of 33, Chancery Lane, in the County of Middlesex, Patent Agent. "IMPROVEMENTS IN LIGHTING BY ELECTRICITY." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

The light giving device or candle is in the form of a solid, such as a cylinder or prism. In the Drawing a form of candle is shown that is convenient for use in the present Invention.

Fig. 1 is a section of the candle showing also the circuit connections.

" 2 is an enlarged section of the candle detached; and

" 3 is a perspective view of the candle portion *a*, which is a slightly tapering hollow cylinder, and split vertically except at the upper end; this ensures uniform and complete incandescence as the electric current passes up one side and down the other.

The base is by preference enlarged, as shown, in order that the electric conductors may be easily connected therewith, and in Fig. 1 a thermal circuit regulator is shown similar to that in Letters Patent No. 4226, granted October 23rd 1878, in Great Britain, to the said Thomas Alva Edison.

The electric current enters at n^1, passes by the wire *k* to the candle *a*, up one side and down the other, there being clamps to connect the wires to the base of the split candle, thence by the circuit regulator *n*, spring L, and clamp to the other wire of the circuit.

If the current is excessive the regulator *n* becomes heated, and expands so as to bring L into contact with the adjusting screw *m*, and short circuit the current and lessen its action in the light.

The special feature of this Invention relates to the candle itself.

Metals or oxides of metals are made use of that produce in a comparatively large candle sufficient resistance to render the whole candle incandescent.

Finely divided metal or particles of metal having a high melting point are caused to adhere by earthy materials, such as magnesium or zircon oxides, or magnetic oxide of iron or other substances that are with difficulty fused. The oxides of metals may be obtained by chemical precipitation or otherwise, and the candle is moulded in either a moist or dry condition by pressure.

The fine particles of metal may be platinum, iridium, ruthinum, or other metal that can only be melted at a very high temperature. The earthy materials should be such as are infusible, such as oxide of magnesia or zirconium, lime, silicum, boron, or other suitable material.

In cases where these oxides or earthy materials are mixed with the fine metallic particles such particles are thoroughly and uniformly mixed into the mass before it is moulded, and hence such particles are kept separate by the earthy material, and cannot fuse or run together, and the metallic oxides themselves are electric conductors to a greater or less extent, and hence may in some instances be used without the particles of metal. In all cases the substances are moulded and pressed into shape under powerful pressure, and if the particles do not adhere together sufficiently sugar, tar, silica, or similar material may be used in moulding the candles to shape, and these substances may be volatilized by the heat.

The metallic particles are rendered highly incandescent, and the earthy materials or oxides also are rendered luminous by the passage of the electric current.

In some instances the rods or prisms of oxides are saturated with a salt of metal difficult of fusion, and this salt is reduced to the metallic state by heat, and the metal permeates the entire body in very minute particles, and these particles are

not liable to be melted and run together in consequence of the intervening oxide or earthy matter.

This Invention is not limited to any particular form in which the candle may be moulded or otherwise shaped, but it relates to the materials employed in such candles, whereby the mass is adapted to the passage of an electric current, and it is rendered highly luminous or incandescent by such current.

Having now described the nature of the said Invention and in what manner the same is to be performed, I declare that,—

What is claimed as the Invention of the said Thomas Alva Edison, and to be secured by Letters Patent is,—

A candle or light giving body for electric lights, in which particles of metal or metallic oxide are moulded into a mass that is adapted to the passage of the electric current and rendered luminous by the same, substantially as set forth.

In witness whereof, I, the said Edward Griffith Brewer, have hereunto set my hand and seal, this Sixth day of May, in the year of our Lord One thousand eight hundred and seventy-nine.

E. G. BREWER. (L.S.)

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1879.

A.D.1878, Nov. 7. No. 4502.
BREWER'S SPECIFICATION.

(1 SHEET.)

FIG. 1.

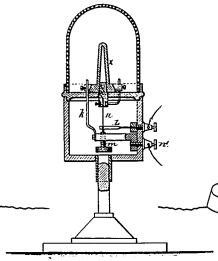


FIG. 2.

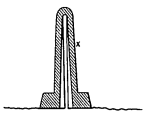
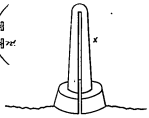


FIG. 3.



Malby & Sons, Photo-Lith.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE
Printers to the Queen's most Excellent Majesty. 1879

A.D. 1878, 28th *December*. N° 5306.

Developing Magnetism and Electric Currents, and Apparatus for Illuminating by Electricity.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENT IN MEANS FOR DEVELOPING MAGNETISM AND ELECTRIC CURRENTS, AND IN APPARATUS FOR ILLUMINATING BY ELECTRICITY."

Sealed the 28th February 1879, and dated the 28th December 1878.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 28th December 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN MEANS FOR DEVELOPING MAGNETISM AND ELECTRIC CURRENTS, AND IN APPARATUS FOR ILLUMINATING BY ELECTRICITY."

The first part of my Invention relates to a dynamo-magneto-electric machine. In machines of this class electric currents have been developed in helices, and a portion of the current has been taken through the helices of the field of force magnets, and other portions have been employed in electric lights and for other uses.

In these machines the currents that pass through the field of force magnets are expended simply in developing magnetism. I have discovered a method of developing magnetism, and increasing the same to the maximum point according to the power employed in rotating the parts, without the use of helices around the field of force magnets; hence the electric current that is developed in the magneto electric machine can be entirely employed for lighting and other uses outside of the machine, instead of a portion being used to develop magnetism.

When a piece of steel is brought within the magnetic field of a permanent magnet the same becomes a magnet. I arrange a machine so that the induced magnetism re-acts upon the permanent magnet to increase its power, and thus develop magnetism by mechanical force in a manner somewhat similar to the development of electricity in a magneto electric machine.

[*Price* 6*d*.]

One of the devices I have employed consists of a shaft having radial bars, which is revolved with the ends of the bars as near as possible to the poles of permanent magnets, and the other poles of the magnets being adjacent to the hub or near the other ends of the bars. In their revolution the bars become magnetized, and increase the magnetism in the permanent magnets until the maximum magnetism is developed.

These magnets are employed as field of force magnets in the magneto electric machine.

The development of a continuous current of electricity is also desirable, for which purpose I employ copper rings or segments around an iron core, and I use mechanical revolution, whereby the electric action, developed upon the general principle of the copper disc between two magnetic poles, as experimented upon by Arago, is converted into a continuously flowing electric current.

I make use of an electric candle composed of a strip of platina or similar metal that withstands a high temperature. The same is made by rolling out flat a strip that is thicker at one edge than the other, and at the same time coiling it into a spiral. It is then coated with a pyroinsulator formed of some oxide or other compound or material, such as asbestos, that is fused with difficulty. The oxides are preferably dissolved in an acid and applied to the helix, and then the salt decomposed by heat. The helix is compressed into a compact cylindrical form, and it is rendered incandescent by the passage of the electric current, and by its expansion it is made to regulate the electric current and prevent injury to the light giving body, as in a Provisional Specification heretofore filed by me. A resistance or rheostat is thrown in or out of circuit, either automatically or in directing the current through the candle, so as to maintain uniformity of resistance.

The aforesaid helix may be polished on the outer edges of the coil, or a cup be used around the same. When finely divided iridium or similar metal not easily fused is mixed with an oxide, such as the oxide of titanium, iron, or other metal that acts as a conductor when highly heated, the resistance is lessened in proportion to the heat, and by properly proportioning the mixture the bar or candle is self regulating to prevent the heat becoming too great.

The conductors are largest near the source of electric energy, and decrease in size in proportion to the number of lights that have been and are to be supplied.

I provide a magnetic safety switch actuated by an electro magnet, so as to supply to each building only the current required, and to disconnect the circuit if the current is too powerful or the wires in the building come into contact. I also provide for storing the electric current or energy, so that the same may be used as required. This is done by the use of secondary batteries, and there are devices for shifting the current from one secondary battery to another periodically, so that one may be in use while the other is being charged from the main circuit. Induction coils when used should be placed with their primary coils in a shunt from the main conductors with current shifting devices, and the secondary currents developed by induction are used in the electric candles.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 28th June 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN MEANS FOR DEVELOPING MAGNETISM AND ELECTRIC CURRENTS, AND IN APPARATUS FOR ILLUMINATING BY ELECTRICITY."

One part of this Invention relates to an electric lamp or burner made from a wire or strip of platina, platina-iridium alloy, or other metal which fuses at a high temperature. This wire or strip I coat with an oxide of metal, such as cerium, lime, magnesia, or other metal or material which will not be injured by a high degree of heat; this coating I term "pyroinsulation."

The wire or strip may be pyroinsulated by dissolving the oxide in an acid, coating the wire or strip with the solution, and then passing the wire or strip through heat from a flame or otherwise, to decompose the solution and cause the deposit of the oxide upon the wire or strip.

If the burner is made of wire, the wire after being pyroinsulated is wound upon a spool or cylinder of lime or other infusible material, and when the burner is placed in an electric circuit and the circuit closed, the electricity passes through the entire length of the wire of the burner and brings it to incandescence. The metallic oxide forms a pyroinsulating coating that protects the metal of the wire, and renders it more difficult to fuse, and prevents the electric current passing from one coil to the next, thereby compelling the current to travel the entire length of the wire.

If the burner is made from a strip of metal, the same should be thicker at one edge than the other, so that it may be rolled to an uniform thickness, at the same time that it is coiled into a spiral. The strip of metal should be thin, so as to obtain considerable length in a short spiral. The spiral or helix thus made is pyroinsulated, as aforesaid, and then compressed into a compact cylindrical form.

Sometimes the pyroinsulating material is placed as a layer between the coils of the spiral or helix.

When the expansion and contraction of the burner *a* is made to regulate the amount of current to the burner, the helix or spiral is placed between heads 2, 3, as shown in Fig. 1, and the rod *b* is connected to the upper head 3 and also to the lever *c*. The lower head 2 is supported by the legs 4, 4. The spiral expands or contracts as a whole, and gives motion by the rod *b* to the bent lever *c*, which latter opens and closes the circuit at 5. When *c* is away from 5 the current enters by wire 7 and passes to the burner, thence by rod *b*, lever *c*, and wire to the line. If the current becomes excessive the heat expands the spiral, raises the rod *b*, and moves the lever *c* into contact with 5, short circuiting or shunting the current, so that it passes by the route having the least resistance, going by 7, 9, 5, *c*, and 8 to line. A resistance coil equal to the resistance of the burner may be placed in this short circuit.

The lever *c* is a safety device which closes the short circuit through the screw 10, in case *c* and 5 should fail to make electrical contact.

Fig. 2 shows in enlarged size a burner made of the flattened pyroinsulated wire, the exterior of the burner may be polished, or the pyroinsulating material may be wholly removed from said exterior surface.

Fig. 3 shows a perspective view of a burner composed of six helices of pyroinsulated wire, each helix being wound upon a spool of infusible material, such as lime, and the spools secured to a divided disk of the same material supported upon metallic rods or half cylinders. The wires 7 and 8 of the line connect to opposite helices as shown, and the helices are connected to each other, hence the current is obliged to pass through all the helices, and brings each helix to the same degree of incandescence.

The thermal regulators set forth in my British Patent of Oct. 23, 1878, may be used for regulating the current to burners made like those in Figs. 1, 2, 3, the special feature of this part of my present Invention relating to the burner made of a wire or strip of metal coated with a pyroinsulating material for the purposes aforesaid.

This pyro-insulating coating allows of very fine wire being used for the burner, hence several layers of the wire may be wound upon the spool of infusible material, and the burner will have a resistance of several hundred ohms which permits of several hundred burners or lamps being connected quantitively in multiple arc, without requiring large main conductors.

In Fig. 4 the burner *a* is made of pyroinsulated wire, and said burner is surrounded by a metal cylinder a^4 which becomes incandescent from the heat of the burner, and radiates the light. The expansion bar b^1, when the heat of the burner exceeds a pre-determined point, moves the lever *c*, and opens the circuit between *c* and 5, and closes the short circuit 0 through 5 and 6, in which short circuit there is a resistance R equal to that of the burner; this arrangement of thermal regulator and circuits is similar to that shown in my aforesaid Letters Patent.

All the burners of wire or metallic strips shown in my aforesaid Letters Patent may be coated with the pyroinsulating material.

In Fig. 5, I have represented a means for pyro-insulating the wire, consisting of a carriage fitted to move back and forth under the stretched wire, and carrying a sponge e^3 moistened with the pyro-insulating solution, and a lamp for drying the coating applied to the wire. The sponge is moistened with a soluble salt of the pyroinsulation, such as the nitrate, oxalate, or acetate of lime, zirconium, magnesium, or cerium, and its group of metals, whose oxides are infusible after being heated. The first passage of the wire in contact with the moistened sponge lays a very thin layer of the solution on the wire, and the heat from the flame which is behind the sponge serves to decompose the salt, driving off the acid and leaving an adherent oxide upon the wire. This operation may be repeated many times, each time the deposit becomes thicker, until the oxide has reached a thickness of about one third that of the wire itself. The wire should be wound upon a spool having a large circumference before being wound upon the spool of the burner to prevent the cracking of the oxide.

In some instances I make a burner or candle of finely divided iridium or other metal that is not easily fused, mixed with an oxide of titanium, iron, or other metal which acts as a conductor when highly heated; this is to be moulded into the desired form, and by properly proportioning the mixture, the current to the burner is regulated by the heat of said burner, the resistance being lessened in proportion to the heat.

Another feature of this Invention relates to the arrangement of the main conducting wires so as to obtain a complete metallic circuit, and at the same time take advantage of the conductivity of the earth, so that the mass of metal in one of the conductors may be reduced; the earth and metallic conductor serve at the same time as a protection for the insulated conductors. Fig. 6 is a diagram illustrating the connections.

The magneto electric machines may be of any suitable character and driven by power. They may be arranged between the two main conductors A, B, in ranges or multiple arcs of three, four, or more in each, and the connections should be for intensity. I have represented four such magneto electric machines M in each range. A is a tube laid in the earth and preferably of iron, and it forms together with the earth one half of the circuit; within this tube is an insulated conductor B, preferably of a number of strands of copper twisted together in the form of a cable, one strand of the cable being dropped, say, every 100 feet, so that at the extreme end of the circuit there shall be but a single strand. This cable is insulated from the tube by any cheap or economical insulation, such as tar or asphaltum. A branch tube ^{2} containing a single strand from the cable is to enter each house or building, and

from the basement smaller wires are run to the various parts of the house where the lights are required.

Each lamp is to be provided with a switch 22 so that it may be disconnected from the conducting wires.

The electric generators at the central station are provided with constant field of force magnets, the helices of which are in the electric circuit, hence if all the lamps feeding from the main conductors are disconnected by their switches the circuit will be broken and no current passes through the conductors leading from the station to the lights, hence the steam engine driving the magneto machines runs lightly and with the expenditure of a very small amount of force. If now the switch of a single lamp is turned the lamp is connected to the branch wires from the main conductors, the circuit is closed, and only sufficient current passes from the central station to supply that lamp because the external resistance determines the amount of current. In this way the current will be proportioned to the number of lamps in the circuit. Each lamp I prefer to contain a resistance, when incandescent, of 1000 ohms. As before described, the connecting of one or more lamps causes a sufficient amount of current to be developed at the central station to keep the same incandescent, it follows that if the machines at the station are arranged expressly for tension and quantity many hundreds of lamps may be placed in circuit between the main conductors, the reduction of resistance upon placing each lamp in circuit drawing the proper quantity of current from the station, hence the greatest economy possible is obtained by causing all the resistance outside of the main conductors to be light giving resistances.

In Fig. 7 I have shown a safety device for shutting off the current from the main wire to the house in case the wires should get "crossed," or from any other cause the current passing to the house should become in excess of that required for the burners. *m* is an electro-magnet in the same circuit as the burners. The armature lever of this magnet is kept upward by means of a spring resting against an adjusting screw, and the tension of this spring is to be such that the lever will not be attracted until the current passing through the magnet reaches a certain intensity. When so attracted the lever is separated from m^1, latched at m^2, and the circuit broken to the house, hence no injury results to the burners from the excess of current on the line. Word must now be sent to the central station, and when the fault is remedied the lever m^3 is unlatched by hand and the circuit again closed to the house by the lever m^3 coming in contact with m^1.

Another part of this Invention relates to means for storing the electric current or energy so that the same may be used as required. This is done by the use of secondary batteries, and there are devices for shifting the current from one secondary battery to another periodically so that one may be in use while the other is being charged from the main circuit.

In the diagram Fig. 8 the circuit connections are illustrated. Fig. 9 is a perspective view of the switch; and Fig. 10 is a side view of the secondary batteries.

The secondary batteries A^3, B^3, are of any desired construction. I prefer and use two sheets of lead wound together into a square or cylindrical form and immersed in acidulated water in a closed case. The main line a^2 is connected with any magneto-electric machine or other source of electric energy, and b^2 is the return line or earth connection. The main line a^2 is connected by the wires c^1 to the secondary batteries A^3, B^3, and the return wires c^3, c^4, pass through the switch *f* and wire 4 to b^2.

The electric lamps are represented in branch circuits between the wires *h* and *k*. The wire *h* connects to one end of the secondary batteries A^3, B^3, and the wire *k* connects to the switch *f*.

The switch *f* is preferably cylindrical with two insulated half cylinders 14 and 15 against which the springs of c^2, c^3, rest, and from these half cylinders are metallic connections to the insulated disks 16 and 17 respectively, against the peripheries of

which the springs of i, k, rest, and this switch can be rotated periodically by a handle, or by clock-work, or other suitable means.

When the switch f is in one position the main circuit is closed through a^2, c^2, A^2, d^1, 14, 16, and i to b^2, and the secondary circuit is closed from B^3 through h, lamps a, wire k, switch 17, 15, and wire c^3 to B^3. When the switch f is in the other position the main circuit from c^2 passes by c^3 to B^3, and by c^3, 14, 16, and i to b^2, while the secondary circuit from A^3 is by h through lamps a, wire k, 17, 15, and wire d^3 to A^3, so that when the secondary battery B^3 is furnishing the accumulated electricity to the lamps a the main current is charging the secondary battery A^3, and *vice versa*.

When a secondary battery is fully charged the decomposition of the liquid commences and gases are developed. I avail of this to actuate a circuit regulator and disconnect the main current.

The two closed cases in which the secondary batteries are placed are provided with tubes s passing to a chamber r beneath a flexible diaphragm t, and in the metallic circuit c^3 there is a switch or lever u that is acted upon to break the electric circuit to the secondary batteries when the gases have accumulated sufficient to move said diaphragm. The accumulated gases combine, and in so doing maintain the electric action of the secondary batteries, and the pressure decreases and the circuit is again closed by the lever u.

Having now described the nature of the said Invention, and in what manner the same is to be performed, I declare that

I claim as my Invention,—

First. An electric lamp or burner made of a wire or strip of metal coated with pyroinsulating material, substantially as and for the purposes specified. Second. The electric lamp or burner made of layers of metal with intervening pyro-insulation, substantially as specified.

Third. The combination with a burner formed of pyroinsulated metal the metal case a^4 surrounding the burner and made incandescent by the heat thereof, substantially as specified.

Fourth. The method of pyroinsulating the wire or strip of metal for the conductor, consisting in passing the wire or strip through a solution of lime, magnesia, or similar material, and then through heat from a flame to effect decomposition of the solution, as specified.

Fifth. The insulated metallic conductors within a metallic case which forms with the earth the return circuit, substantially as specified. Sixth. The combination with electric lamps and a main circuit of two secondary batteries and circuit connections and switch, substantially as set forth, to alternately change the main and secondary circuits, substantially as specified.

Seventh. The combination with a secondary battery and its enclosing case of a diaphragm or similar device acted upon by the accumulation of gas pressure, and a switch or lever moved by such diaphragm to disconnect the main circuit from the secondary battery, substantially as set forth. Eighth. An electro-magnet m in the same circuit as the lamp or burners in combination with the armature lever m^2, latch m^3, and contact m^4, substantially as and for the purposes set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Fourth day of June, A.D. 1870.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 140, Nassau St., N.Y.,
WILLIAM G. MOTT, 140, Nassau Str., N.Y.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1879.

FIG. 8.

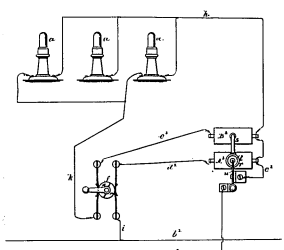


FIG. 9.

FIG. 10

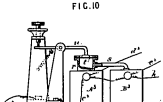
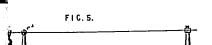


FIG. 5.



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A.D. 1878, Dec. 28. No. 5306.
EDISON'S SPECIFICATION.

(1 SHEET)

FIG. 1.

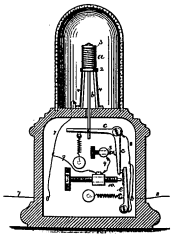

FIG. 6.

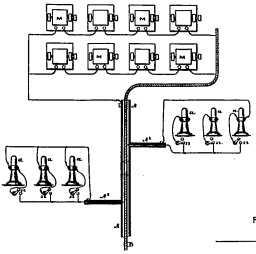

FIG. 8.

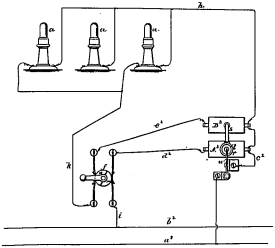

FIG. 7.

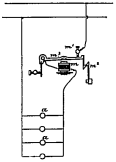

FIG. 2.

FIG. 3.

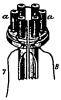

FIG. 4.

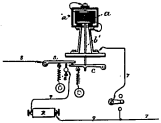

FIG. 10

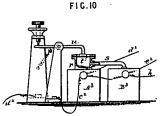

FIG. 9.

FIG. 5.

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Printers to the Queen's most Excellent Majesty. 1878

A.D. 1878, 23rd *October*. N° 4226.

Developing Electric Currents and Lighting by Electricity.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENT IN THE METHOD OF AND MEANS FOR DEVELOPING ELECTRIC CURRENTS AND LIGHTING BY ELECTRICITY."

Sealed the 14th January 1879, and dated the 23rd October 1878.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 23rd October 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN THE METHOD OF AND MEANS FOR DEVELOPING ELECTRIC CURRENTS AND LIGHTING BY ELECTRICITY."

I make use of an electric generator in the form of a very large tuning fork, the same may be magnetized or not, and the same is firmly supported in the middle, and the free ends are vibrated by mechanical force, such as small steam cylinders, with a piston rod connected to each end of this fork, or any other device, such as a crank, may be used to keep the free ends in vibration; but little power is required to keep up the rate and amplitude of vibration that would result if the free ends were drawn aside and then allowed to vibrate like a tuning fork. The mechanical force applied to keep this large fork in vibration is converted into electricity by placing upon the fork several magnets, and opposite to them stationary electro-magnets, the helices of which are so connected by commutators that the induced current set up in the helices by the approach and recession of the cores will be conveyed to a line upon the principles known in connection with magneto-electric machines.

The electric energy thus set up is carried by a wire to the lighting apparatus next described; or it may be used at a distant station for vibrating by magnetism a similar large tuning fork, from which mechanical movement can be given by the

[*Price* 1*s*.]

action of a pawl on a wheel or a crank moved by the mechanical vibrations of the tuning fork.

The electric light is derived by the passage of the current through a spiral coil of wire, or through a leaf or strip of metal, or through carbon or any other material that will become incandescent. The incandescence of bodies under electric action has been known, this portion of my improvement relates to the manner of regulating the current, so that it can never become so intense as to melt or injure the light-producing body. To effect this I make use of an automatic apparatus that becomes operative according to the intensity of the current to check, divert, or partially neutralize the action of the current in the light-giving body.

The heat developed is caused to expand a wire or other body either by the passage of electricity through it or by its proximity to the source of light, and this expansion gives a mechanical movement through a lever or similar device to operate a circuit closing device, to shunt or short circuit more or less of the current, or to throw a resistance into the circuit, and thereby lessen the electric current passing through the light-giving body and prevent injury to the same. The same result is attained by the expansion of confined air acting on a diaphragm, or by directing a current of air upon the light-giving body to lessen the temperature thereof. And in some instances I employ a secondary battery in a local circuit, that is opened or closed mechanically to throw the electric energy into the coils of platina or other light-giving bodies; a number of these coils or light-giving bodies are placed in one circuit, and means employed for preventing the breaking of the circuit by any injury to one of the lights.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 23rd April 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN THE METHOD OF AND MEANS FOR DEVELOPING ELECTRIC CURRENTS AND LIGHTING BY ELECTRICITY."

The first feature of this Invention relates to a means for developing a current of electricity by mechanism, so as to obtain the necessary electrical force cheaply; and the second part of this Invention relates to the electric light itself, the method of regulating the intensity of the light and preventing injury to the same, and the peculiar devices that are employed in an incandescent state to give the light.

It has long been known that if two electro-magnets, or an electro-magnet and a permanent magnet, be drawn apart or caused to pass by each other, that electric currents will be set up in the helix of the electro-magnet.

It has also been known that vibrating bodies, such as a tuning fork or a reed, can be kept in vibration by the exercise of but little power. I avail of these two known forces, and combine them in such a manner as to obtain a powerful electric current by the expenditure of a small mechanical force.

In Fig. 1 of the Drawing a tuning fork a^2 is represented as firmly attached to a stand b^2; this fork is preferably of two prongs, but only one might be employed upon the principle of a musical reed. This vibrating bar or fork may be two metres long, more or less, and heavy in proportion; it has its regular rate of vibration like a tuning fork, and the mechanism that keeps it in vibration is to move in harmony; a crank and revolving shaft, or other suitable mechanism, may be employed, but I prefer a small air, gas, or water engine applied to each end of the fork.

The cylinder a^1 contains a piston and a rod b^1 that is connected to the end of the bar, and steam, gas, water, or other fluid under pressure acts within the cylinder, being admitted first to one side of the piston and then the other by a suitable valve; the valve and direct-acting rod c^2 are shown for this purpose.

The bar or fork a^2 may be a permanent magnet or an electro-magnet, or also it is provided with permanent or electro magnets. I have shown an electro-magnet c^3 upon each prong of the fork, there may be two or more on each, and opposed to these are the cores of the electro-magnets d, hence as the fork is vibrated a current is set up in the helix of each electro-magnet d in one direction as the cores approach each other, and in the other direction as they recede.

This alternate current is available for electric lights, but if it is desired to convert the current into one of continuity in the same direction a commutator is employed, operated by the vibrations of the fork to change the circuit connections each vibration, and thereby make the pulsations continuous on the line of one polarity.

A portion of the current thus generated may pass through the helices of the electro-magnets c^3 to intensify the same to the maximum power, and the remainder of the current is employed for any desired electrical operations wherever available.

I however use the same especially with my electric lights, but I remark that electricity for such lights may be developed by any suitable apparatus.

I have represented commutator springs or levers c^5, c^4, operated by rods that slide through the levers c^2, c^1, and by friction move them. When the prongs a^2, a^2, are moving from each other the contact of levers c^5, c^4, will be with the screws 40, 41, and the current will be from line 1 through c^4 to c, thence to c^2, to 41, 43, and to circuit of electro-magnets d, d, and from d, d, by 42 to 40, c^4, and line as indicated by the arrows. When the prongs a^2, a^2, are vibrating towards each other the circuit will be through c^5, c, c^2, 42, in the reverse direction through the circuit and magnets d, d, back to 43 and by c^4 to line.

Edison's Improvement in Developing Electric Currents & Lighting by Electricity.

Platinum and other materials that can only be fused at a very high temperature have been employed in electric lights, but there is risk of such light-giving substance melting under the electric energy. This portion of my Invention relates to the regulation of the electric current, so as to prevent the same becoming so intense as to injure the incandescent material. The current regulation is primarily effected by the heat itself, and is automatic.

In Fig. 2 I have shown the light-producing body as a spiral *a* connected to the posts *b*, *c*, and within the glass cylinder *g*. This cylinder has a cap *l* and stands upon a base *m*, and for convenience a column *n* and stand *o* of any suitable character may be employed. Most of the other Figures are in the form of diagrams to more clearly represent the electrical connections. I remark that it is preferable to have the light within a case or globe, and that various materials may be employed, such as alum water, between two concentric cylinders to lessen radiation, retain the heat, and lessen the electric energy required, or colored or opalescent glass, or solutions that reduce the refrangibility of the light, such as sulphate of quinine, may be employed to modulate the light; and the light may either be in the atmosphere or in a vacuum.

The materials that I have found especially adapted to use as light-giving substances are set forth hereafter.

The electric circuit, *Fig.* 2, passes by line 1 to the post *r* and by a wire to the lever *f*, thence by the wire or rod *k*, cap *l*, wire *c*, to the post *c*, through the double spiral *a* to the post *b*, and by a metallic connection or wire to the post *n* and line 4, and so on through the electric circuit and the light be developed in *a*.

The rod *k* will expand in proportion to the heat of the coil or in proportion to the heat developed by the passage of the current through the fine wire *k*, and if the heat becomes dangerously high injury to the apparatus is prevented by the expansion of rod *k* moving the lever *f* to close the circuit at *i* and short circuit or shunt a portion of the current from the coil *a* and reducing its temperature; this operation is automatic and forms the principal feature of my Invention, because it effectually preserves the apparatus from injury.

The current need not pass through the wire or rod *k* as the expansion thereof by the radiated heat from the coil *a* will operate the lever *f*, as indicated in Fig. 3, but the movement is not so prompt.

If the light-giving body is a globule or small bar of silicon, boron, titanium, or other substance, between carbon, platinum, or other metal rods, as shown in Fig. 4, the spring f^1 will be employed to press the lever *f* and hold the parts in position. The expansion of the parts *a*, *k*, by the heat from the current short circuits the current as before.

In Fig. 5 the lever *f* is represented as within a glass, so that a vacuum can be employed. The rod *k* may be of carbon, titanium, oxide, or any other conducting body.

In Fig. 6 the expansion rod *k* is represented as adjacent to the light-giving body and acted upon by radiated heat as well as by the heat from the passage of the current.

In Fig. 7 is represented a light-giving body formed of a platina or similar wire around which carbon is made to adhere by pressure; the same becomes luminous by the action of the electric current.

In Fig. 8 the spiral *a* is similar to that in Fig. 2, but a spring *t* is used as a safety to maintain the electric circuit unbroken if the wire *k* or coil *a* should fuse and thereby break the circuit; the current passes by wire 1, contact point 2, and block *i*, to line 4 when switch *x* is in contact with 2; this throws the light out of action; but when *x* is moved to 3 the current goes by 1, *f*, *k*, *a*, to *i* and line 4; but if *a* or *k* is broken the spring lever *f* closes to *t* and current goes by 1, *f*, *t*, to 3, and by switch *x* to *i* and line 4.

In Fig. 9 the switch *x* when swung into contact with 2 presses the spring *t* upon lever *f* and short circuits the current from *k* and *a* through the rheostat R that is of equal resistance to the light-giving material. When the switch *x* is moved

Edison's Improvement in Developing Electric Currents & Lighting by Electricity.

to 3 the light is brought into action, and the lever *f* regulates the current as before described.

In Fig. 10 the switch *x* when at 3 allows the current to pass through the resistance coil R or rheostat that is of equal resistance to the light-giving material, so that other lights are not influenced by lighting or extinguishing one electric light; the other parts are like Fig. 2.

Fig. 11 represents an electric light like that shown in Fig. 6, only a spring and arm *f* take the place of the lever.

Fig 12 corresponds to Fig. 7 except that the spring arm *f* is used instead of the lever.

Fig. 13 represents a carbon pencil or rod and spring lever; the carbon itself in this case expands when the current is too strong and the spring short circuits the current and becomes as before an automatic thermal regulator.

In Fig. 14 the light-giving body *a* is represented as a strip of platina or similar foil, and there is a safety switch *t* in the form of a spring, and this is used in addition to the spring or lever *f*, so that in case of the spring being interfered with at *i* by dust or oxyd upon the contact points the rod *k* by a slight additional expansion touches the safety spring *t* and short circuits the current.

Fig. 15 represents two strips of platina *a*, a^1. If the strip *a* expands under heat so as to cause lever *f* to leave spring lever f^1 and break the circuit, that cannot happen until the spring f^1 rests upon the contact point *i*; this allows the electric circuit to divide and pass through both *a* and a^1; this reduces the temperature of both and the two are maintained in the circuit until the contraction of *a* separates f^1 and *i*.

In Fig. 16 the lever spring f^1 when it comes in contact with *i* closes the shunt circuit through the rheostat R, that lessens the power of the current on the platina strip *a*. The spring *s* is adjustable to maintain the proper tension on the lever *f*.

In Fig. 17 the end of the spring lever *f* rests upon a small platina wheel 10 that is upon an arbor in jaws at the end of the screw 11. When this screw is turned one way it causes the wheel to touch the spring and extinguishes the light by short circuiting it. When the screw is turned the other way the contact is broken and the light induced. By the movement of the jaw and roller up and down the platina wheel is revolved progressively by two stationary spring pawls 12 and 13 acting on a ratchet wheel on the arbor of the wheel 10. By this device a new contact surface is brought into action each time the light is turned on.

In Fig. 18 three bent levers *f* are shown, the vertical ends being in a cup of mercury to which one line wire is connected. The circuit passes through these levers *f* and foil *a*, but when the foil becomes too hot it expands and allows the levers to make contact with *i* and short circuit the current; one of the three levers will be almost sure to operate, but if not and the light-giving body *a* still expands the point 15 will touch the spring 16 and throw the circuit through the resistance R. In place of the levers last described three or more springs may be used, as in Fig. 19, the action being the same as levers; or four or more springs may be used as in Fig. 20, there being an adjustable spring 18 to apply a slight tension to the strip of platina and to preserve the continuity of the circuit should the springs fail to connect. The automatic thermal circuit regulation is in some instances effected by the heat given by the electric light to air or gas in a confined vessel. The apparatus, Fig. 21, corresponds generally to that shown in Fig. 2, except there is a diaphragm *v* of thin metal or other material across below the perforated base that holds the glass *g*, so that this diaphragm will be pressed downward by the expansion of the air contained in the glass, and when the maximum temperature is obtained the current will be short circuited by the point on the diaphragm making contact with the insulated spring 21. The current passes by the wire 1, metallic head *l*, incandescent strip *a*, metallic base *m* and column, to the line 4. When the heat of the spiral reaches within a few degrees of the melting point of said spiral the air in the

glass g has become expanded and the diaphragm is bulged outwardly and makes contact within the spring 21 and the current is short circuited; the current now being through wire 1, spring 21, diaphragm v, metallic base m and column, to the line 4. If the circuit should fail to close by the contact of the diaphragm and spring 21 the further movement of the diaphragm will bring the spring 21 in contact with the screw 4, and the short circuit will be through the spring 21, screw 4, and metallic column to the line 4. It is to be understood that in all cases the action of the short circuit or shunt is momentarily to lessen the current through the light-giving substance, and the circuit-closing devices play up and down at the contact point maintaining uniformity of brilliancy in the light.

The device shown in Fig. 22 acts the same as before indicated, but the coil is horizontal and the wires reach it by passing through a piece of chalk or similar material resting upon a base m and the short circuiting is by contact with the screw 5 of a platina projection on the diaphragm. A spring circuit closer may be used as shown in dotted lines. If mercury or a liquid is introduced in the confined space 15 containing also the light, and the air or gas heated thereby, a tube may lead to a circuit-closing cup, as shown in Fig. 23, to short circuit the current when the maximum temperature is obtained.

In lighting by electricity it is often important to use a secondary battery in connection with the main current. The diagram, Fig. 24, shows four electric light coils a, a, a, a, in a secondary circuit containing cells S, B, with platines in a conducting liquid, and the lever 28 is vibrated by an electro-magnet 29 or by clock work; when the lever 28 is in contact with 29, the current from line 1 passes through 29 and S, B, to 4, but when 28 leaves 29 the line is closed, but a local circuit is made between 28 and 30 through the coils a and secondary battery, the discharge of this secondary battery gives the light, and the movement is so rapid that the light appears continuous. A single secondary battery may be introduced with one or more lights, as in Fig. 25, the expansion of the light-giving material short circuiting the current through the secondary battery S, B, the light-giving device may be a spiral such as that shown in Fig. 2, the same being illustrated by dotted lines. A coil a^2 may be used in a vessel containing water or other fluid, as seen in Fig. 26, said coil being of less resistance than the light, so as to heat the water and operate the circuit-closing diaphragm. Instead of a rheostat in the shunt circuit I sometimes employ a button of carbon 32, as seen in Fig. 27. In this case the spring lever f bearing upon the carbon button lessens the resistance by the increase of pressure as the platina strip expands, and as it contracts and lessens the pressure on the carbon button the resistance of that carbon button increases and a greater portion of the current is sent through the platinum strip; this regulation is very accurate. If a helix of wire 33 is placed in the same position as the carbon as seen in Fig. 28, the action will be the same, for when the coils of the helix touch each other the resistance will be less in the shunt than when the helix is distended by the contraction of the platina strip or wire a, and the proportion of current passing through a may be increased by the contraction of a, and the reverse. This construction prevents electric sparks, as the metallic circuit is continuous. When an electro-magnet is introduced in the electric circuit, and its armature spring is set up strongly, so that it will not respond until the maximum current is flowing through the circuit, then the movement of the armature can be made to short circuit the light-giving body, as illustrated in the diagram, Fig. 29, and thereby lessen the current at the light, or it may be made to throw in a resistance or rheostat R to lessen the flow of the current, as shown in Fig. 30. One lever f or spring circuit closer may be made to regulate the flow of electricity through several lights. The diagram, Fig. 31, illustrates several lights placed in one or more derived circuits, each light being regulated independently by its own thermal regulator. Fig. 32 represents ranges of lights, one branch circuit being connected at the upper ends of the lights, and the other circuit wires to the lower ends to the circuit-regulating levers. Fig 33 illustrates the circuit connections of ranges of lights, in which the top of one light is connected with the bottom of the next, the

circuit-regulating springs f always acting in the circuit. The magneto-electric machine or other source of electricity is represented at a^3.

A variety of helices, coils, ribbons, and other forms of light-giving materials are illustrated in Fig. 34 to 42, and in Figs. 48, 49, and 50, and I remark that in all cases the light is due to the incandescence of the body, and that the thermal regulator of the circuit is to be adjusted or made to act automatically to lessen the electric current before the same becomes sufficiently intense to injure the light-giving substance; this point will vary according to the material employed in the light. A cylinder of platina foil around a rod of lime gives an excellent light, and strips, wires, rods, beads, and pieces of iridium, ruthinum, rhodium, osmium, titanium, and other metals that fuse at a high temperature may be used; also conducting oxides may be used, such as oxides of titanium. In Fig. 43 the two strips of platina a, a^1, are connected at their ends to the large and small pulleys 50 and 51, and the lower end of a is connected to the spring f, and of a^1 to the block 52. If the foil a^1 expands, it allows the pulleys to be rotated by the spring f, drawing off foil from 50, and thereby increasing the length of the foil that is incandescent, and increasing the resistance in the circuit. The same effect is produced by the device shown in Fig. 44, in which the axial electro-magnet a^3 has a suspended core; as the electric current increases the core is drawn into the helix and the pulleys 50 and 51 turned so as to lengthen the strip of foil a. Fig. 45 shows a cylinder of platina foil a as the light-giving material. Fig. 46 shows a magnet a^2 in the wire between 1 and 4. When the spring f touches 4 the current passes through the magnet, and its armature closes a metallic circuit that divides the electric current so that it does not all pass through the foil. In Fig. 47 the lever f, as it descends, comes into successive contact with the yielding points 56, and the current passes more freely from 1 to 4 in proportion as the one or more of the resistance coils may be short-circuited by the lever f.

When the electric force is generated by a magneto-electric machine, it is important to regulate the speed of the machine in proportion to the strength of the current, so as to prevent injury to the machine when the electric lights are extinguished. I effect this either by an index or galvanometer at the central station to denote to the engineer the strength of the current, so that he can regulate the machine, or slow a governor is employed to throw in resistance or to short circuit the electric current.

Fig. 51 is a modification of the device shown in Fig. 21. There is a chamber g^2 connected by a tube to the glass g, and this chamber g^2 is covered by a diaphragm g^3, over which is a lever f. When the spiral a reaches its maximum heat, the expanded air acts upon the diaphragm g^3 and moves the same, so that it is brought in contact with the lever f; this in its turn makes contact with the screw 4, and the current is short-circuited.

Fig. 52 shows another arrangement of parts, whereby the heated air in the glass g operates the lever that short circuits the current when the burner reaches its maximum heat. The glass g rests upon the top of the case or box h^4, and within this box there are flexible chambers h^5, h^6, similar to those used in an aneroid barometer; there is an opening in the top of the box, through which a tube from the chamber h^5 passes, so that the air may have free passage from the glass globe or shade g to said chambers. Upon the under part of the lower chamber there is a lever f connected thereto at f^4 and pivoted at f^5, and a contact point f^6 on said lever is contiguous to the lever f^7 that is pivoted to the adjustable block f^8.

The current enters by the line 1 and passes by the screw 23, spring 22, and wire to the lever f^7, thence by contact f^6, and wire to the metallic support f^{10} and burner a, and by the other metallic support f^{11} to the wire 30 and line 4. When the maximum heat is attained by the burner, the heated air as it expands acts within the flexible chambers h^5, h^6, and bulges them downwardly, moving the lever f, and bringing the point f^6 in contact with the lever f^7, and breaking the circuit between f^7 and f^6 to the burner a. The current now passes by line 1,

screw 23, spring 22, wire 24, lever f^7, contact f^6, lever f, resistance coil B, and wire 30, to line 4.

The resistance R is equal to that of the burner a, and said resistance prevents excessive sparks at the contact points. The block f^3, upon which the lever f^7 and point f^6 are attached, is movable, and is adjustable by the screw f^{12}. By moving the block f^3 towards the burner, the circuit is broken to the lamp and closed through f^7 and f^6, and in so doing the circuit from 1 is broken between the spring 23 and screw point 22. The reverse movement causes the lamp to be automatically connected.

The burner shown in Fig. 52 is composed of six spirals connected as shown in Fig. 55, so that the electric current passes through all of them.

In Fig. 54 the same arrangement of circuits is shown as in Fig. 52, but the heated air acts upon mercury in a tube to expand the mercury, move a float, and operate the levers f^7 and f, and thereby break the circuit to the lamp, and close it to the rheostat R.

In the sectional elevation, Fig. 56, and sectional plan, Fig. 57, the thermal regulator is similar to that shown in Fig. 20, but the burner or lamp is upon a swinging arm or bracket, so that it can be swung like a gas fixture. The bracket a^8 is sustained by a socket and pin at b^8. I is one of the electric conductors; the same is insulated and passes into an opening in the bracket, and thence to the electric light, and the return circuit is through the pipe a^9 to the wire 4, or to the gas pipe if the bracket is upon a gas pipe. The circuit-closing levers f are within and pivoted to a metallic case a^5 that is provided with a door for allowing access to the parts. The levers are sustained at their moving ends by a yoke a^{10}, see Fig. 58, connected to the light-giving body a, and said moving ends are contiguous to a platina bar i on a block adjustable by the screw a^{11}. The current enters by the wire 1, and passes to the plate a^{12}, wire a^{13}, head l, light-giving body a, levers f, case a^5, bracket a^8, to the line 4. If the heat of the burner a becomes too high, the light-giving body expands and allows the levers f to drop and make contact with i, and thus offer a short route for the current, the same passing by the wire 1, plate a^{12}, wire a^{14}, block i, levers f, case a^5, bracket a^8, and line 4.

Fig. 53 is a diagram, illustrating a method of measuring the amount of electricity used. c^1 is a box into which the wires c^2, c^{10}, from the main conductors enter. R^{19} is a coil of very large wire, whose resistance is proportioned to the number of burners used in the house. This resistance is but the fractional part of the resistance of a single lamp. An electrolytic cell c is used as the meter; this cell, which contains a solution of copper, has two electrodes of copper, one of which is very thick, while the other is very thin.

The small portion of the current which passes through the cell carries over copper and deposits it upon the thin plate. If one lamp is placed in connection, it draws current from the main, and a proportionate quantity passing through the cell effects a deposit upon the thin plate; if another lamp is connected, double the quantity is deposited, and so on. At the end of any period, say one month, the plate is taken by the inspector to the central office and accurately weighed. As the deposit of copper upon the thin plate will be proportioned to the total amount of current passing into the house, the same becomes a correct measure or standard for the charge for the electricity supplied.

When the deposited plate is taken out another one is to be substituted.

In said Fig. 53 I have shown a single lamp a, having, say, 1000 ohms resistance placed in one branch, and in another branch I have shown four electric candles or burners a^1, a^2, a^3, a^4, in one lamp, the burners being in close proximity and arranged in two branch circuits, the resistance of each branch being 2,000 ohms; the two one lamp a. By this arrangement various numbers of lamps may be placed in branches will jointly offer a resistance of 1,000 ohms the same as the resistance of each branch. Between the same main conductors and the resistance be equal in 55

In Fig. 59 the thermal regulation is effected by the electro-magnets c^6, c^7. The current from one line passes through the spiral a, and then through the electro-magnets c^6, c^7, lever c^8, contact screw c^9, lever c^{16}, and screw c^{11} to the other line wire 4. The levers are provided with retractile springs, and their tension is adjusted so that the magnets will not attract the levers if the current is of such intensity as to produce the proper incandescence of the light-giving body; if the intensity of the current should exceed this proper point, then the magnets attract their levers and keep them vibrating, thus breaking the circuit at the points c^9 and c^{11}, and weakening the current passing through the burner a.

Two magnets are used in order that the spark at the contact points may be lessened.

Fig. 60 shows the same form of thermal regulator as that shown in Fig. 59, but only one magnet is employed.

In Fig. 61 the lever c^8 of the electro-magnet c^6 acts upon a lever c^{12} that has a spring to draw it towards c^{14}. When the current is of the proper intensity the circuit passes through the spiral a, magnet c^6, lever c^{12}, and contact c^{13} to the line 4; if the current becomes too intense the lever of c^6 is attracted and the lever c^{12} is moved from c^{14} breaking the circuit to the burner; this is but momentary, for the spring c^{15} draws the lever c^8 upwards, and this latter moves the lever c^{12}, again closing the circuit to the burner, and if the current continues to be too intense, the lever c^8 is kept vibrating, opening and closing the circuit and weakening the current to such an extent as to prevent all danger of the fusion of the light-giving body. In Fig. 62 the lever c^8 acts upon a lever c^{12} and opens the circuit more quickly than by the direct action of the lever c^8.

In Fig. 63 the circuits are so arranged that the magnet c^6 is in a branch circuit and the current divides, part going to the magnet and the principal part to the light. If the current becomes too intense the magnet attracts the lever c^8 and breaks the current at c^9.

Fig. 64 shows a magnet provided with two coils, the current passing through in opposite directions. The coil i^2 is of large wire and is in the main circuit with the burner, while the coil i^3 is of great resistance and shunts the burner and coil i^2. The inequality of the resistance of the burner produced by rise of temperature serves to disturb the balance, the magnet i^2 becomes energized and attracts the lever i^8 and opens the circuit.

Fig. 65 shows a thermal regulator consisting of a bent tube containing mercury, which latter is expanded or contracted by the heat of the current passing through the same. A float in the mercury at the open end of the tube is connected to the lever f, and there is a second lever f^1 provided with a contact point or screw that presses upon f^1 so long as the electric current is of the proper intensity. As the mercury expands and by the float raises the lever f, the lever f^1 rises also and presses the continuity of circuit until f^1 touches the stationary contact i; then if the mercury continues to expand f separates from f^1 and the circuit to the burner a is broken.

The device shown in Fig. 66 operates the same as that in Fig. 60, but the electro-magnet is adjustable nearer to or further from its armature lever in order that said lever may vibrate quickly or slowly according to the distance of the armature lever and magnet from each other. In Fig. 67 the lever c^8 is kept away from the magnet c^6 by a flat spring c^{17} instead of a retractile spring; said spring c^{17} is upon a block moved by the screw c^{18} so that the spring can bear with more or less pressure upon the armature lever and thus determine the point at which the lever will be attracted by the magnet and consequently regulating the amount of current passing to the burner a.

In Fig. 68 a thermal regulating coil is shown within the flexible aneroid chambers k^2, k^3, the heat from the coil acts upon the air within said chambers and operates the levers f, f^1, the same as has been described with reference to Fig. 52.

I claim as my invention,—

First. The combination with an electric light of a thermal circuit regulator to

Edison's Improvement in Developing Electric Currents & Lighting by Electricity.

lessen the electric action in the light when the maximum intensity has been attained, substantially as set forth.

Second. The combination with the electric light of a circuit-closing lever operated by heat from the electric current or from the light, and a shunt or short circuit to divert the current or a portion thereof from the light, substantially as set forth.

Third. The combination with the electric light and a resistance of a circuit closer operated by heat, and serving to place more or less resistance in the circuit of the electric light, substantially as set forth.

Fourth. The combination with an electric light of a diaphragm operated by the expansion of a gas or fluid in proportion to the temperature of the light to regulate the electric current, substantially as set forth.

Fifth. The combination with a vibrating body, similar to a tuning fork, of mechanism for maintaining the vibration, and magnets, cores, and helices, whereby a secondary current is set up so as to convert mechanical motion into electric force or the reverse, substantially as set forth.

Sixth. The combination with electric lights, substantially such as described, of means for regulating the electric current to the same in proportion to the heat evolved in the light so as to prevent injury to the apparatus, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Second day of April, A.D. 1879.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
STOCKTON L. GRIFFIN, of Menlo Park, N. J.
GEORGE E. CARMAN, " "

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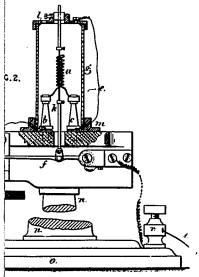
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1879.

A.D.1878. Oct. 23. N°4226
EDISON'S SPECIFICATION

(5 SHEETS)
SHEET 1.



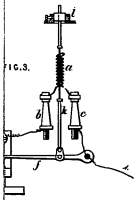


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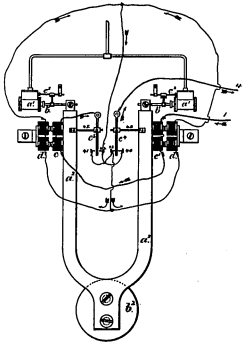
FIG. 1.



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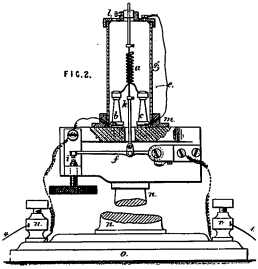
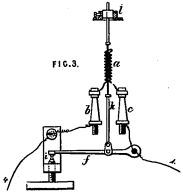


FIG. 3.



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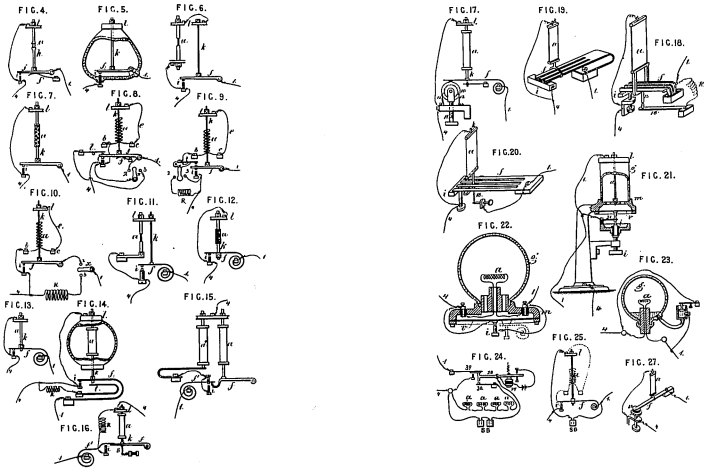

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A.D.1878. Oct.23. N°.4226.
EDISON'S SPECIFICATION.

(5 SHEETS)
SHEET 3.

FIG. 28.

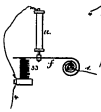
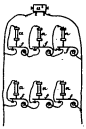


FIG. 29.

FIG. 30.

FIG. 31.



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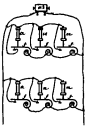


FIG. 33.

FIG. 34.

FIG. 35.

FIG. 36.

FIG. 37.

FIG. 38.

FIG. 39.

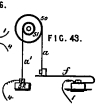
FIG. 40.

FIG. 41.

FIG. 42.

FIG. 26.

FIG. 43.



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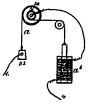

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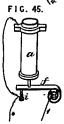
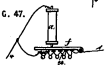


FIG. 46.

FIG. 47.



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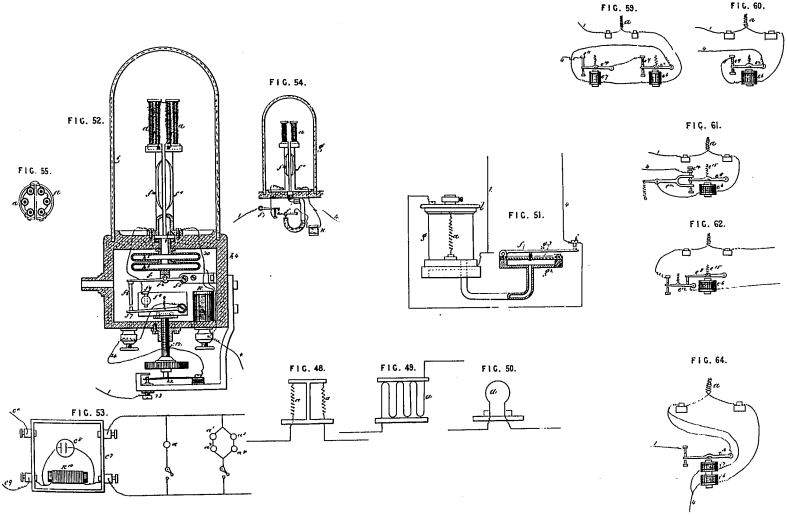

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A.D.1878. Oct.23. No.4226.
EDISON'S SPECIFICATION.

(5 SHEETS.)
SHEET 5.

FIG. 56.

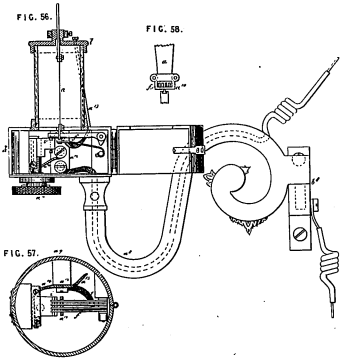
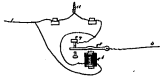


FIG. 58.

FIG. 57.

FIG. 63.



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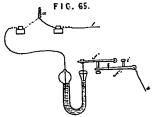


FIG. 67.

FIG. 66.

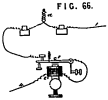
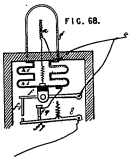


FIG. 68.



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A.D. 1879, 17th *June.* Nº 2402.

Electric Lights and Apparatus for Developing Electric Currents, &c.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, Electrician, for the Invention of "IMPROVEMENTS IN ELECTRIC LIGHTS, AND IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME."

Sealed the 14th October 1879, and dated the 17th June 1879.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 17th June 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America, Electrician. "IMPROVEMENTS IN ELECTRIC LIGHTS, AND IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME."

I have ascertained that when wires or sheets of platina, iridium, or other metallic conductors of electricity which fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there is revealed myriads of cracks in every direction, many of which are seen to reach nearly to the centre of the wire. I have also discovered that contrary to the received notion platinum and iridium alloy loses weight when exposed to the heat of a candle, that even heated air causes it to lose weight, that the loss is so great that it tinges a hydrogen flame green, and under the influence of an electric current and at a yellow white heat the loss is very great. After a time the metal falls to pieces, hence wire or sheets of platinum, or platinum or iridium alloy, as now known in commerce, are useless for giving light by incandescence.

First, because its loss of weight makes it expensive and unreliable, and causes the burner to be rapidly destroyed.

Second, because its electrical resistance changes by loss in weight and its light giving power by the cracks or ruptures, the melting point being determined by the weakest spot where the greatest difference of potential of the electric current is present, which causes this point to be brought to a higher heat than the rest of the surface of the wire; again, as it is essential to obtain a steady light the

[*Price* 10*d.*]

platinum burner must be screened from the air, and when thus screened by being placed in a glass vessel the glass soon becomes coated with a black deposit of platinum.

A platinum spiral brought to incandescence under these conditions may be made to give a light of three standard candles when near its melting point, and when the radiating surface is $^3/_{16}$ of an inch, but this amount of light will be rapidly reduced as before described.

From my researches and experiments I am led to believe that the cause of the rupturing of this metal when brought to incandescence is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores during the rolling or drawing of the sheet or wire.

These gases or air when subjected to high heats are greatly expanded and rupture the metal, and it cannot be driven out by slowly heating the metal.

I have also discovered that the loss of weight and apparent volatilization of the metal is due to the action of the air or gases against the highly heated surface. Having thus ascertained the cause of fracture and loss of weight I have conducted experiments to obviate these defects, and have succeeded by the following method:—A spiral of platinum wire is placed in a glass bulb, with its ends passing through and sealed in the glass, and the air exhausted from the bulb by a Sprengel pump, until the discharge from a three inch induction coil will not pass between two subsidiary wires in the bulb, the ends of which are four millimetres apart; the wires of the spiral are then connected to a magneto electric machine or battery whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150° Fahrenheit; it is allowed to remain at this temperature for 10 or 15 minutes; while thus heated the air or gases in the pores of the metal is expelled by the action of the heat and the expansion of the gases which tend to pass outward in consequence of the vacuum. While this air or gases is passing out of the metal the mercury pump is kept continuously working. After the expiration of about 15 minutes the current passing through the metal is to be augmented so that its temperature will be about 300 degrees Fahrenheit, and it is allowed to remain at this temperature for another 10 or 15 minutes. If the mercury pump be worked continuously and the temperature of the spiral raised at intervals of 10 or 15 minutes until it attains to vivid incandescence, and the bulb be then sealed, the metallic wire is then in a state heretofore unknown, for it may have its temperature raised to the most dazzling incandescence, emitting a light of 25 standard candles.

Whereas before the treatment the same spiral would only emit a light equal to three candles before attaining the melting point. The wires subjected to the process of freeing them from air and gases are found after the process to have a polish exceeding that of silver, and obtainable by no other means, no cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and no volatilization takes place as there is no deposit upon the glass bulb, nor does a delicate balance show any loss of weight in the spiral after burning for many hours continuously, because the spiral is in a vacuum that is so nearly perfect that the action of the gaseous molecules is reduced to the minimum, and were it possible to obtain an absolute vacuum there would be no loss whatsoever, and the total loss after a year's use would scarcely be noticed. I have further discovered that if an alloy of platinum and iridium, or even platinum be coated with the oxide of magnesium in the manner hereafter stated, and subjected to the vacuum process described, that combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral, having a radiating surface of $^3/_{16}$ of an inch, light equal to that given by 40 standard candles may be obtained, whereas the same spiral not passed through my process would melt before giving a light of 4 candles.

The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral spring made of the wire is as elastic and springy when at dazzling incandescence as when cold.

I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equal to that of platinum in the open air.

Carbon sticks may be also freed from air in this manner and be brought to a temperature, that the carbon becomes pasty, and if then allowed to cool is very homogeneous, and hard rods or plates made of mixtures of finely divided conducting and non-conducting materials may thus be freed from air. It is also obvious that the metal might be heated by subjecting the containing bulb to a considerable temperature, but this only partially frees the wire from its air or gases.

I will now describe the form of burner of lamp which I employ.

To operate several hundred electric lights practically, each equal to an ordinary gas jet, upon one circuit, it is essential for many reasons, both on the score of economy, facility, and reliability, to place them all in multiple arc, and to prevent the combined resistance of several hundred lamps from falling to such a low point as to require main conductors of immense dimensions with low resistance, and generating machines of corresponding character, it is essential to reverse the present and almost universal practice of using lamps which have but one or two ohms resistance, and construct lamps which shall have, when giving their proper light, a resistance of several hundred ohms, because the more lamps there are in circuit the less will be the resistance. I have ascertained by experiment that the loss of energy is in proportion to the extent of the radiating surface independent of the resistance of the conductor; hence we have 100 lamps, each of $^1/_4$ of an inch radiating surface, and each of 1 ohm resistance, or 1,000 lamps having the same radiating surface and 1,000 ohms resistance each; the loss of energy from each lamp, when giving each a light of 15 candles, will be nearly the same, but the combined resistance of the 1 ohm lamps will be $\frac{1}{1000}$ of an ohm, requiring an enormous main conductor, whereas the combined resistance of the 1,000 ohms lamp will be 1 ohm, requiring a conductor of very moderate dimensions. In practice, a resistance of 200 to 300 ohms in the burner will be sufficient.

Again, with lamps of low resistance, the lamp connections and leading wires must be large to prevent great loss of energy by resistance, the leading wires from the main conductors are large, expensive, and bulky to handle, the low resistance of the burner or incandescent conductor requires large terminals to convey the current, and these offer by their conduction a medium for the rapid dissipation of energy without producing any effect, whereas with a lamp of high resistance all these objections are obviated.

My burner consists of a bobbin composed of an infusible oxide, such as oxide of calcium, corium, zirconium, magnesium, freed from silica, and turned in a lathe from sticks moulded by hydraulic pressure in a manner hereinafter set forth.

These wires serve to hold the bobbin in the centre of the sealed glass vacuum bulb and at the same time serve as conductors of the electric current to the wire coiled upon the bobbin.

The two platinum wires are first passed through small tubes of glass which are melted round the wires. The burner is introduced into the bulb and the wires are passed out through the sides of the narrow neck leading from the bulb, and the glass is melted around them to prevent leakage, the glass of the neck being melted to the small glass tube around the wires.

Before the burner is permanently sealed at the neck the air pump is connected therewith and the wire upon the bobbin is subjected to the vacuum process heretofore described, and the electric current is used to produce incandescence for about one hour to heat the bobbin and thereby expel the air and gases, after which the bulb is permanently sealed by melting the glass of the neck, and it is ready to be used as a lamp.

The method which I adopt for regulating the light radiated from the burner consists in a small rotating magnet provided with a governor which serves to open the lamp circuit when the strength of the current is greater than is necessary to

produce the proper light in the bobbin. This apparatus is very reliable, and although the current supplied is not perfectly continuous the total energy passing to the lamp in one hour is nearly the same, no matter what the strength of the current may be. The magnets are so arranged that the continuous metallic circuit cannot be broken by the commutator of the revolving magnet and the extra current produced by the reversal of the current in the revolving magnet is short circuited by the fixed magnet, hence the sparks which would occur at the break points of the governor are prevented.

The rotating magnet is upon a vertical shaft supported in suitable bearings, and immediately over the rotating magnet is the fixed magnet, the cores of which are in the path described by the rotating magnet. Upon the shaft is a reversing commutator formed of an insulated ring, the periphery of which is faced with platina and cut in two parts, one part being connected by a wire to one helix of the revolving magnet and the other part to the other helix of said magnet, the two helices being connected. Rubbing on this ring are two contact springs which serve to convey the currents to the revolving magnet.

The current passes through the fixed magnet, thence through the revolving magnet, the rotation of the magnet being kept up by the reversal of the direction of flow of the currents through the revolving magnet.

When the cores of the revolving magnet are nearest the cores of the fixed magnet the direction of the flow of current is reversed by the action of the commutator springs and commutator, and the polarity changed; hence the attraction ceases, but the momentum of the revolving magnet carries said magnet forward, and mutual attraction again takes place; as the revolving cores approach the stationary cores the current is reversed and the revolution continued.

Connected to the revolving shaft is a governor which consists of two collars connected together by two springs; one collar is secured to the shaft while the other is free to slide thereon.

Upon each spring a weight is secured, and the rotation of the shaft causes these to act centrifugally, and bow outwards the springs, and raise the sliding collar upward, more or less in proportion to the speed of the shaft.

The sliding collar is made with a groove to receive the end of the circuit opening lever, which lever is moved by the rise and fall of the collar. The other end of the lever has an insulated cross bar which is in contact with two circuit breaking springs, and serves to disconnect the springs simultaneously from their contact points or blocks when the shaft has reached a certain velocity.

The object of using two springs is to open the circuit at two places simultaneously and thus reduce the spark, which it does in the ratio of the number of simultaneous breaks.

One of the two springs is connected by a wire to one of the commutator springs and the other is connected to the wire leading from the main conductor or a branch therefrom. This method of breaking the circuit simultaneously in many places is applicable to all kinds of electrical apparatus where large and powerful sparks occur, as, for instance, if it is desired to transfer electric energy from one point to another by dynamo electric machines operating upon a magneto electric motor at a distant station. If four springs are employed and the circuit opened at the four places simultaneously the spark will be reduced to $^1/_{16}$ of what it would be if it was opened at but one place.

The block to which the two circuit breaking springs are secured is connected to a screw so that said block and springs can be positioned or adjusted with reference to the cross bar on the governor lever.

By turning this screw to the right the block and springs are moved until the cross bar moves the springs away from their contact points or bars, and disconnects the lamp from the circuit; the reverse movement places the lamp in circuit, and, according to the proximity of the springs to the cross-bar of the governor lever, so the amount of current to the burner is regulated. A stop is applied to the screw so that it can be turned only to a determined point which limits the amount of current

passing to the burner. I prefer that each burner shall give a light equal to 16 candles, the burner being capable of giving 35 candle power without fusion.

As there may be a point where the revolving magnet, after being at rest, will not start when the current is put on, I use an automatic starter which consists of a light lever and thin armature turned edgewise, which is attracted by the fixed magnet at the moment the current is put on. The movement of this lever, which carries upon its end a click, serves to give a sudden motion to the shaft of the revolving magnet by the click engaging in a ratchet or toothed wheel secured to the shaft.

The click, after making this movement, passes beyond the ratchet and does not come in contact again until the magnet is stopped and the current is broken.

In the Specification of my British Patent, No. 5306, of 1878, I have described the manner of coating the wire with pyroinsulating material. I employ that mode in coating the wire, after which a coil of said wire is wound upon one or more lime supports and placed in a sealed bulb that is connected to a Spengel vacuum apparatus, and by gradually increasing the heat of the wire by the gradual rise in the strength of the current, as described in the first part of this Specification, the wire is not only freed from air and rendered more refractory, but the oxide is vitrified and shrinks upon the wire, from which it cannot be detached.

The coil, after passing through this process, may be wound upon the lime bobbin of the lamp without breaking the pyroinsulation.

After the bobbin is wound and placed in the final bulb it has any air which may have passed into the oxides expelled by a gradual accession of current in the manner heretofore described, and the bulb is then sealed.

The oxides of the alkaline materials which are infusible attack the platina to a slight extent, and, as herewith, greater tenacity to it than the oxides which do not attack it, such as cerium or zirconium; but the compound thus formed renders the wire more refractory.

It is not essential that the oxide should be in the form of a soluble salt, as it may be put on the wire directly by mechanically mixing the oxide with water, alcohol, or other liquids, but special devices are requisite to keep the mixture in constant agitation to prevent settling.

It has been found very difficult to mould slender sticks of the oxides enumerated on account of the bending and breaking of the plunger of the mould, which, owing to the pulverulent nature of most of the oxides, must be long and slender.

I have obviated this difficulty by devising a mould and plunger by which pressures to the crushing point of steel may be concentrated upon one quarter of an inch surface.

This apparatus is applicable to the moulding of any substance.

The block that receives the mould is of cast iron, with a taper hole in the centre. The mould is made of three pieces, and has the same taper as the hole in the block.

The object of the taper and split mould is to allow the pressed piece to be taken out without injury, which it would receive were it forced out of the mould endwise.

The plunger is upon the end of a sliding stock, and said plunger is only about ¾ of an inch long and about $^5/_8$ of an inch in diameter, and it is adapted to pass downwardly into the hole in the centre of the split mould.

After the mould has been filled to the top with the pulverulent oxide a steel washer or punch section is placed upon the oxide and forced into the mould by the plunger. Afterward another punch section is placed upon the first one and forced into the mould in the same manner. Thus sections may be added until the desired pressure is obtained without any disarrangement of the apparatus. So powerful is the pressure which may be obtained by this means that cylinders of the oxide of magnesium are rendered semi-transparent.

The cylinder of oxide thus obtained is placed on a lathe and the bobbin turned with a cutting tool without fear of breaking.

The electric generating machine which I propose to use consists of a powerful field magnet, between the poles of which rotate an induction bobbin.

The cores of the field magnet are each three feet in length and about six inches

in diameter, and wound with a helix of insulated copper wire having a resistance of about one ohm.

The number of coils and the resistance of the wire may of course be varied to suit various conditions. By the use of large masses of iron I am enabled to reduce the resistance of the magnetic circuit to a very low point, and at the same time by reason of this large mass of iron of great magnetic conductivity the use of a single layer of wire is possible, thus obtaining the maximum economy.

The back or bar that connects the two cores of the magnet is of iron, and is greater in mass than in the same length of core. The surface of both the back and the end of each core are ground together, and are permanently secured by bolts and nuts. By thus employing a large mass of iron for the back, and grinding the faces of contact to a point where air suction becomes powerful, I reduce the resistance of this point to a minimum and prevent the appearance of free magnetic poles.

There are iron poles bolted to the cores, the surfaces being ground together.

Between the two poles there is a circular aperture in which the induction cylinder rotates.

The cylinder may be of wood upon a shaft, and at each end of the cylinder there is a wrought iron head.

This cylinder or bobbin is wound with fine wire until the wire is flush with the edge of the iron heads.

Over this cylinder is wound longitudinally the insulated induction wire, the ends of which are connected to the commutator. The wire of the parallel induction helix is substantially endless, and it is wound with reference to obtaining a continuous current.

The number of parallel coils may be more or less in number, but I find the desired object can be obtained by using an even number of parallel coils longitudinally of the cylinder, and an odd number of the commutator plates.

There are two insulated discs upon the shaft of the field magnet, and a metallic brush or spring is in contact with each disk; the line wires are connected to these disks. One end of the wire of the field magnet is connected to one disk, and the other end of the wire is connected with one of the commutator brushes; the other commutator brush is connected with the second insulated disk.

The path of the current is through one insulated disk to the field magnet, through it to one commutator block, then through the induction coil to the opposite block on the commutator, and by brush and wire to the second insulated disk, and thence to the line.

The current will be continuous, or nearly so, and travel in one direction; there will however sometimes be a spark between the commutator bars when the circuit of the parallel induction coil is interrupted, but this will be lessened by having the commutator springs bent to rest on more than one commutator bar.

It will be apparent that the shell and parallel induction coil may be revolved if the magnet-cylinder remains stationary; and I remark that the cylinder supporting the parallel induction coil may be of any suitable material, but I prefer vulcanized fibre.

The parts of this machine are not liable to become heated under ordinary circumstances of use, because the wires are not wound one on the other and the atmosphere has an opportunity to circulate.

I however apply a fan in some instances upon the shaft of the field magnet within a case communicating with the internal portions of the machine, so as to induce a current of air through the same.

As I have heretofore set forth the maximum economy of illuminating by electricity when using a great number of light giving points is only obtainable by working the resistance in multiple arcs, hence it is also necessary that the generating machines should also be worked in multiple arc.

To work a great number of machines in multiple arc with economy and reliability it is essential that all should have the same electro motive force, and that means must be devised to prevent the insulating covering of the induction bobbin

of any machine being burned should the same stop for any reason, such as by the breaking of a belt; because if the wire of the bobbin cease to be the seat of an electro motive force the current from the other machines pass through it and tend to produce sufficient heat to destroy the insulation, and at the same time cause a loss of available energy.

I prevent any such action by the use of a polarized magnet, which prevents the electric circuit being opened by the direction of the flow of the current from the machine when in action tending to hold its tongue strongly against a contact point, but if the machine should stop and cease to be the seat of an electro motive force, a current from the other machines passes through the machine in a contrary direction, whereupon the tongue of the polarized magnet is attracted from its contact point and the circuit opened.

Each machine being provided with this apparatus, it is freed from the danger aforementioned.

An ordinary magnet with its armature lever provided with a retractile spring might replace the polarized magnet, but the margin for adjustment would be very small.

The resistance of the polarized magnet is made an exceedingly small fraction of the resistance of the machine to prevent loss of energy.

The field magnets of the machine are energized by supplying their helices with electricity from thermo-electric piles.

Compound condensing steam engines are employed at the large central stations to drive the magneto electric machines, and the heat given off from the surface condensers acts upon thermo-electric piles to produce an electric current, and the same is passed through the field of force helices.

The field magnets may all be connected in multiple arc, and the thermo electric piles arranged in the same manner with appliances whereby the strength of all the field may be increased or decreased at pleasure, thus increasing or decreasing the electro motive force of the induction bobbins, thus making it easy and convenient by the aid of electro meters at the central stations to counteract the rise and fall in the electro motive force on the main conductors when the maximum and minimum number of lamps may be working.

I will mention that the electro motive force of the machine is analogous to the pressure in the system of gas lighting and at dusk when the lamps are being rapidly connected to the circuit the electro meter will shew a slight drop on the electro motive force or pressure, and this may be increased by increasing the speed of the prime mover or increasing the power of the field magnets; the later method is the one I prefer.

The surface condensers which I employ consists of a great number of iron pipes whose surfaces are painted with a thick coating of a non-conducting substance. The pipes after painting are about five inches in diameter.

Over these pipes are slipped rings of the double sulphide of lead and copper. These rings are cast in a mould, and both the inner and outer edges are either covered or plated with copper.

The inner copper ring of one disk connects with the outer copper ring of the adjoining disk throughout the entire series of disks.

Owing to the exceedingly low resistance of these disks and the considerable electro motive force which they give between the low range of temperature very powerful currents are obtained, and nearly as much energy is thus obtained in the form of an electric current from the waste heat of the engine as can be obtained from the engine itself through the medium of the Faradic machines.

In British Letters Patent, No. 4226 of 1878, granted to me, a method is described and shewn for measuring the total energy passing into the house of the consumer during a given period of time, the same consisting of a depositing cell or cells in which the weight of copper deposited by the current gives the indication.

Instead of the cell or cells shown two cells connected by a syphon may be used.

In one cell is a solution of cuprie sulphite and a copper electrode, and in the other

cell sulphuric acid and a copper electrode. No polarization takes place; the liquid of the syphon tube offers the requisite resistance.

The cells are sealed from the air to prevent loss by evaporation.

Any loss by this means may be made good by adding water, the results are nearly independent of the strength of the solution.

The central stations are intended to light an area of ¼ of a mile in every direction. The method which I propose to adopt for conveying the current from the central station to various points, consists in laying double wrought pipes lined with vulcanized rubber, known as ebonite, side by side under the flagging stones, near the edge of the sidewalk. The pipes are to be 20 feet lengths, the four ends passing into a cast iron box.

The pipes and box are water-tight.

The top of the box, which is detachable, has its upper surface even or flush with the walk; from the same box small tubes serve to convey wires from the main conductors to the houses of the consumers.

The wires forming the main conductors are small, and may either be insulated and laid loosely together or insulated with a thin layer of cotton. In this case each consumers wire will be independent, but the economy is greater when the wires are all in contact, as then when few lamps are in use the resistance of the main conductor is relatively small as compared to the lamps.

The practice of causing the total resistance of the circuit extraneous to the generator to be equal to that of the generator, and by which the maximum effect is obtained from the machine, is very wasteful of energy; for by thus arranging the resistances fifty per cent. of the energy is lost in the machine itself, whereas if the exterior resistance is four times greater than the machine the capacity of the machine to translate energy from one to the other is lessened, but of what is translated, owing to the changed conditions, 80 per cent. may be utilized.

For this reason I so arrange the resistance of the main conductors that they should be but $^1/_{10}$ of the total resistance of all the lamps, and the resistance due to the generating machine is kept down by keeping in multiple are a greater number of machines than is necessary to supply all the lights which may happen to be in circuit at the time.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 17th December 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America, Electrician. "IMPROVEMENTS IN ELECTRIC LIGHTS, AND IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME."

I have ascertained that when wires or sheets of platina, iridium, or other metallic conductors of electricity which fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours, by passing a current of electricity through them, and then are allowed to cool, the metal is found to be ruptured, and under the microscope there is revealed myriads of cracks in every direction, many of which are seen to reach nearly to the center of the wire.

I have also discovered that contrary to the received notion, platinum or platinum and iridium alloy loses weight when exposed to the heat of a candle, that even heated air causes it to lose weight, that the loss is so great that it tinges a hydrogen flame green, and under the influence of an electric current and at a yellow white heat the loss is very great. After a time the metal falls to pieces, hence wire or sheets of platinum or platinum and iridium alloy as now known in commerce are useless for giving light by incandescence, 1st., because its loss of weight makes it expensive and unreliable, and causes the burner to be rapidly destroyed. 2nd, because its electrical resistance changes by loss in weight and its light giving power by the cracks or ruptures, the melting point being determined by the weakest spot where the greatest difference of potential of the electric current is present which causes this point to be brought to a higher heat than the rest of the surface of the wire. Again, as it is essential to obtain a steady light the platinum burner must be screened from the air, and when thus screened by being placed in a glass vessel, the glass soon becomes coated with a black deposit of platinum. A platinum spiral brought to incandescence under these conditions may be made to give a light of three standard candles when near its melting point, and when the radiating surface is $^3/_{16}$ of an inch, but this amount of light will be rapidly reduced as before described.

From my researches and experiments I am led to believe that the cause of the rupturing of the metal when brought to incandescence is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores during the rolling or drawing of the sheet or wire. These gases or air when subjected to high heat are greatly expanded and rupture the metal, and it cannot be driven out by slowly heating the metal.

I have also discovered that the loss of weight and apparent volatilization of the metal is due to the action of the air or gases against the highly heated surface.

Having thus ascertained the cause of fracture and loss of weight, I have conducted experiments to obviate these defects and have succeeded by the following method.

A spiral of platinum wire is placed in a glass bulb with its ends passing through and sealed in the glass, and the air exhausted from the bulb by a Sprengel pump until the discharge from a three inch induction coil will not pass between two subsidiary wires in the bulb, the ends of which are four millimetres apart. The wires of the spiral are then connected to a magneto electric machine or battery whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150° Fah., it is allowed to remain at this temperature for 10 or 15 minutes. While thus heated, the air or gases in the pores of the metal are expelled by the action of the heat and the expansion of the gases which tend to pass outward in consequence of the vacuum.

While the air or the gases are passing out of the metal the mercury pump is

kept continuously working. After the expiration of about fifteen minutes the current passing through the metal is to be augmented so that its temperature will be about 300° Fahr., and it is allowed to remain at this temperature for another ten or fifteen minutes. If the mercury pump be worked continuously, and the temperature of the spiral raised at intervals of ten or fifteen minutes until it attains vivid incandescence, and the bulb be then sealed, the metallic wire is then in a state heretofore unknown, for it may have its temperature raised to the most dazzling incandescence, emitting a light of twenty-five standard candles, whereas before treatment the same spiral would only emit a light equal to three candles before attaining the melting point. The wires subjected to the process of freeing them from air and gases are found after the process to have a polish exceeding that of silver, and attainable by no other means; no cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and no volatilization takes place as there is no deposit upon the glass bulb, nor does a delicate balance shown any loss of weight in the spiral, even after said spiral has been burning for many hours continuously, because the spiral is in a vacuum so nearly perfect that the action of the gaseous molecules is reduced to the minimum, and were it possible to obtain an absolute vacuum there would be no loss whatever.

I have further discovered that if an alloy of platinum and iridium, or even platinum, be coated with the oxide of magnesium in the manner hereafter stated, and subjected to the vacuum process described, that combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral having a radiating surface $^3/_{16}$ of an inch, light equal to that given by forty standard candles may be obtained, whereas the same spiral not passed through my process would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory.

A spiral spring made of the wire is as elastic and springy when at dazzling incandescence as when cold.

I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equal to that of platinum in the open air.

Carbon sticks may be also freed from air in this manner and be brought to a temperature that the carbon becomes pasty, and if then allowed to cool is very homogeneous and hard. Rods or plates made of mixtures of finely divided conducting and non conducting materials may thus be freed from air.

It is also obvious that the metal might be heated by subjecting the containing bulb to a considerable temperature, but this only partially frees the wire from its air or gases.

I will now describe the form of burner or lamp which I employ. To operate several hundred electric lamps practically, each equal to an ordinary gas jet, upon one circuit, it is essential for many reasons, both on the score of economy, facility, and reliability to place them all in multiple arc, and to prevent the combined resistance of several hundred lamps from falling to such a low point as to require main conductors of immense dimensions with low resistance, and generating machines of corresponding character, it is essential to reverse the present and almost universal practice of using lamps which shall have but one or two ohms resistance, and construct lamps which shall have, when giving their proper light, a resistance of several hundred ohms, because the more lamps there are in the circuit the less will be the resistance. I have ascertained by experiment that the loss of energy is in proportion to the extent of the radiating surface independent of the resistance of the conductor; hence we have 1,000 lamps, each of $^1/_4$ of an inch radiating surface, and each of one ohm resistance, or 1,000 lamps having the same radiating surface and 1,000 ohms resistance each, the loss of energy from each lamp when giving each a light of fifteen candles will be nearly the same, but the combined resistance of the one ohm lamps will be $^1/_{1000}$ of an ohm, requiring an enormous main conductor,

whereas the combined resistance of the 1,000 ohm lamps will be one ohm, requiring a conductor of very moderate dimensions. In practice a resistance of 200 to 300 ohms in the burner will be sufficient. Again, with lamps of low resistance the lamp connections and leading wires must be large to prevent great loss of energy by resistance; the leading wires from the main conductors are large, expensive, and bulky to handle; the low resistance of the burner or incandescent conductor requires large terminals to convey the current, and these offer by their conduction a medium for the rapid dissipation of energy without producing any effect, whereas with a lamp of high resistance all these objections are obviated.

My burner *b* consists of a bobbin composed of an infusible oxide, such as oxide of calcium, cerium, zirconium, magnesium, freed from silica and turned in a lathe from sticks molded by hydraulic pressure in a manner hereinafter set forth, and upon this bobbin fine wire of platinum or platinum-iridium alloy is coiled. This bobbin is shown in Fig. 1; it is secured to two platinum wires 1, 2, as in Fig. 2. These wires serve to hold the bobbin in the center of the sealed glass vacuum bulb, and at the same time serve as conductors of the electric current to the wire coiled upon the bobbin. Fig. 3 shows the manner of connecting the wire upon the bobbin to the platina supports. The two platina wires 1, 2, are first passed through a small tube *a* of glass, and the glass melted around the wires. The burner *b* is introduced into the bulb *c*, and the wires 1 & 2 are passed out through the sides of the narrow neck leading from the bulb, and the glass is melted around them to prevent leakage; the glass of the neck is melted to the small glass tube *a*. Before the burner is permanently sealed at the neck the air pump is connected therewith and the wire upon the bobbin is subjected to the vacuum process heretofore described, and the electric current is used to produce incandescence for about one hour to heat the bobbin, and thereby expell the air and gases, after which the bulb is permanently sealed by melting the glass of the neck, and it is ready to be used as a lamp, as represented in Fig. 4.

The method which I adop for regulating the light radiated from the burner consists in a small rotating magnet provided with a governor, which serves to open the lamp circuit when the strength of the current is greater than is necessary to produce the proper light in the bobbin. This apparatus is very reliable, and although the current supplied is not perfectly continuous the total energy passing to the lamp in one hour is nearly the same, no matter what the current strength may be, the magnets being so arranged that the continuous metallic circuit cannot be broken by the commutator of the revolving magnet, and the extra current produced by the reversal of the current in the revolving magnet is short circuited by the fixed magnet, hence the sparks which would occur at the break-points of the governor are prevented. Referring to Fig. 4, *b* is the bobbin with the platinum iridium wire which forms the electric lamp, *c* is the sealed glass bulb; *f* and *g* are supports to hold the bulb in position; these are insulated from each other. The platinum wires 1 and 2 from the bulb are connected to these supports.

m is a box for supporting the lamp and enclosing the governor; *n* is the back of the fixed magnet, consisting of the spools *o*, o^1; *p*, p^1, are the spools of the revolving magnet; *r* is the back of the same, which is secured permanently to the shaft *q*, upon which is a revolving commutator *s*. This commutator consists of a ring of insulating material, whose periphery is faced with platina and cut in two parts, one part being connected by the wire 5 to the magnet p^1, and the other part by the wire 4 to the magnet *p*. The wire 65 connects the two spools *p* and p^1 together.

Rubbing on this ring are two contact springs s^1, t^1, which serve to convey the currents to the revolving magnet. The current passes through the fixed magnet *o*, o^1, see diagram Fig. 5; thence by wires 4, 5, springs s^1, t^1, through the revolving magnet *p*, p^1. The rotation of the magnet is kept up by the reversal of the direction of the flow of the currents through the revolving magnet. When the cores of the revolving magnet are nearest the cores of the fixed magnet the direction of the current through the former is reversed by the action of the springs s^1, t^1, upon the

commutator and the polarity changed, hence the attraction ceases; but the momentum of the magnet p, p^1, carries it forward, and mutual attraction again takes place; as the revolving cores approach the stationary cores the current is reversed and the revolution continued.

Connected to the revolving shaft q is the governor, which consists of two collars v, w, connected by springs 6 & 7, the collar v is permanently secured to the shaft, while the collar w is free to slide up and down upon it. Each spring is provided at its center with a weight, and these weights act centrifugally to bow outwardly the springs and raise the collar w upwardly more or less in proportion to the speed of revolution. Connected to w by a sleeve is another collar 19, upon the surface of which rests the end of the circuit opening lever l, which rises and falls by the action of the governor. A spiral spring l^1, see Fig. 5, on the axis of the lever l serves to keep it in contact with 19. Upon the extreme end of the lever l is a block 18 in juxtaposition to circuit breaking springs 8 & 9, and serves to disconnect the springs simultaneously from the metallic block 10, when the governor and shaft has reached a certain velocity. The block 10 is insulated from the frame 11, and serves to keep the circuit closed between the springs.

The current passes by wire 84 to the spring 8, thence across the block 10 to the spring 9, thence to the magnet and lamp by wire 85.

The object of employing two springs is to open the circuit in two places simultaneously and thus reduce the spark, which it does in the ratio of the square of the number of simultaneous breaks. This method of breaking the circuit simultaneously in many places is applicable to all kinds of electrical apparatus where large and powerful sparks occur; as for instance, if it is desired to transfer electric energy from one point to another by dynamo electric machines, the distant machine, which serves 25 to give out the power for driving machinery, may be provided with a governor the same as herein shown, and the circuit may be opened in several places simultaneously by the action of the governor shown in Fig. 6. l is the lever operated by the governor; 12 and 13 are contact springs, which rest upon the bar 43; 14 and 15 are also contact springs which rest on the bar 44. The current passes by wire 84 30 to spring 12, across the bar 43 to spring 13, thence by wire 45 to spring 14, across bar 44 to spring 15 to wire 85. When the governor reaches a certain velocity the insulated piece 18 of the lever l comes in contact with all the springs simultaneously and separates them from the bars 43 & 44, thus opening the circuit in four places simultaneously, the spark is reduced to $\frac{1}{16}$ of what it would be if a single break 35 was used. Having shown the importance of breaking the circuit simultaneously in many places I will now describe how the illumination of the burner b may be increased or decreased, or stopped entirely.

Referring to Figs. 4 & 5 i is the thumb nut for regulating the speed of the revolving magnet and consequently the amount of energy which passes to the 40 burner. The nut 22 is provided with a slot or groove containing a stationary pin p^3, and into the nut 22 the screw 20 passes, and by turning this screw the block 10 may be drawn inwardly or forced outwardly, said block running on two guide pins 23, 24, which prevent the block from turning; thus the block 10 may be made to approach or recede from the lever l. 45

If it is desired to turn off the light and disconnect the lamp altogether from the circuit, the screw is turned to the right until the block 18 separates the springs 8 & 9 from the block 10 and opens the circuit. In this position the circuit is broken and the lamp and magnets are entirely disconnected from the circuit.

If it is desired to have the lamp give light the screw is turned to the left; when 50 the springs 8 & 9 come in contact with the block 10 and close the circuit, the magnets immediately revolve; and if the parts are left in such a position that the piece 18 is in close proximity to the springs, the rotation of the magnet will operate the governor and lessen the pressure of 8 and 9 on 10, and hence the speed will be comparatively slow and the electricity passing to the light will be very small and 55 but little light will be given out, but by causing the block 18 to further recede

from 8 & 9 the speed of the magnet will increase and more energy will pass to the lamp in a given time.

By continued turning of the screw 20 a point may be reached where the governor lever l will not separate the springs 8 & 9 from 18; in this case the entire electric energy passes through the bobbin b, but in practice limiting stops are applied so that when the screw has been turned a certain distance the further movement will be prevented by the action of the stops, thereby determining the maximum light which the consumer can obtain from the burner. In practice this will be about sixteen candle power, the burner being capable of giving thirty five candle power without fusion.

As there may be a point where the revolving magnet after being at rest will not start when the current is put on I use an automatic starter which consists of a light lever and thin armature turned edgewise which is attracted by the fixed magnet at the moment the current is put on. The movement of this lever which carries upon its end a click serves to give a sudden motion to the shaft q by the click engaging in a ratchet or toothed wheel which is secured to it. The click after this movement passes beyond the ratchet and does not come in contact again until the magnet is stopped and the current is broken.

In the Specification of my British Patent, No. 5306, of 1878, I have described the manner of coating the wire with pyroinsulating material; I employ that mode in coating the wire after which a coil of said wire is wound upon one or more bobbins and placed in a sealed bulb, and connected to a vacuum apparatus, and by gradually increasing the heat of the wire by the gradual rise in the current strength, as described in the first part of this Specification, the wire is not only freed from air and rendered more refractory, but the oxide is vitrified and shrinks upon the wire from which it cannot be detached. The coil after passing through this process may be wound upon the lime bobbin of the lamp without fear of breaking the pyroinsulation. After the bobbin is wound and placed in the final bulb any air which may have passed into the oxides is expelled by a gradual accession of current in the manner heretofore described, and the bulb is then sealed. The oxides of the alkaline materials which are infusible attack the platina to a slight extent and adhere with greater tenacity to it than the oxides which do not attack it, such as cerum or zirconium, but the compound thus formed renders the wire more refractory.

It is not essential that the oxide should be in the form of a soluble salt, as it may be put on the wire directly by mechanically mixing the oxide with water, alcohol, or other liquids, but special devices are required to keep the mixture in constant agitation to prevent settling.

It has been found very difficult to mold slender sticks of the oxides spoken of on account of the bending and breaking of the plunger of the mold, which owing to the pulverulent nature of most of the oxides must be long and slender.

I have obviated this difficulty by devising a mold and plunger by which pressures to the crushing point of steel may be concentrated upon one quarter of an inch surface. This apparatus is applicable to the molding of any substance, and it is shown by a vertical section in Fig. 7. Fig. 8 is a plan of the divided mold. a^2 is the plunger; upon the extreme end is the part d^2 which enters the die or mold. This is only about one quarter of an inch long and about three eighths of an inch in diameter, and it is adapted to pass downwardly into the mold.

e^2 is a solid block of cast iron with a taper hole in its center, and into this the divided steel mold f^2 is forced; this mold is made of three pieces, and has the same taper as the hole in the block e^2. The object of the taper and divided mold is to allow the pressed piece to be taken out without the injury it would receive were it forced out of the mold endwise. After the mold has been filled to the top with the pulverulent oxide a steel washer or plunger section h^2 is placed upon the oxide and forced into the mold by the plunger; afterwards another plunger section is placed upon the first one and forced into the mold in the same manner. Thus sections may be added until the requisite pressure is obtained without any

disarrangement of the apparatus. So powerful is the pressure which may be obtained by this means that cylinders of the oxide of magnesium are rendered semi-transparent. The cylinder of oxide thus obtained is placed in a lathe, and the bobbin turned with a cutting tool without fear of breaking.

The electric generating machine which I propose to use consists of a powerful field magnet between the poles of which rotate an induction bobbin. This apparatus is shown by a vertical section in Fig. 9, and sectional plan Fig. 10. F is the field magnet, the cores of which are about three feet in length and the diameter about six inches, wound with a helix of insulated copper wire having a resistance of about one ohm. The number of coils and the resistance of the wire may of course be varied to meet various conditions. By the use of large masses of iron I am enabled to reduce the resistance of the magnetic circuit to a very low point, and at the same time by reason of this large mass of iron of great magnetic conductivity the use of a single layer of wire is possible, thus obtaining the maximum economy. a^3 is the back of the magnet, and the mass of iron is greater than in the same length of core. The surface of both the back and the end of each core are ground together and are permanently secured by bolts and nuts. By thus employing a large mass of iron for the back and grinding the faces of contact to a point where air suction becomes powerful, I reduce the resistance of this point to a maximum and prevent the appearance of free magnetic poles; a^4, a^5, are iron poles bolted to the cores, the surfaces being ground together. Between the two poles there is a circular aperture in which the induction cylinder rotates. The cylinder b^2 is preferably of wood upon the shaft b^4, and has wrought iron heads b^3. This cylinder is wound with fine iron wire b^5 until the wire is flush with the edge of the iron heads b^3. Over this cylinder is wound longitudinally the insulated induction wire in sections, the ends of which are connected to the commutator c^3, as in Fig. 11. There are heads c^2 of hard rubber, vulcanite, fiber, or equivalent material secured to the shaft b^4, see Figs. 16 and 17, outside the heads b^3, and are of larger diameter, so that the induction wires c^4 that are wound longitudinally may be kept from contact with the iron helix b^5 or heads b^3, so that the current may not be short circuited even if the insulation of the induction wires c^4 is imperfect. c^5 is a pulley for driving the machine; c^6 is a loose pulley upon which the belt from the driving shaft is thrown by a shifter when the machine is to be stopped.

c^7 is a switch by means of which the circuit from the Faradic machine may be opened; d^3 and d^5 are the commutator springs; h^2 is a polarized magnet included in the circuit, which serves automatically to open the circuit should a reverse current be sent through the machine. The connections are as follows:—From the post c^8 to the commutator c^1, thence through the induction helix c^4 to the opposite side of the commutator, and by the brush d^2 to the switch c^7; thence to the tongue 40 of the magnet h^2, if the switch lever is in contact with c^8; thence through the tongue of h^2 to the point c^9, and through the magnet h^2 to the post h^1. The wire upon the field magnet is connected to the clamping posts l^3 and l^4. I will now describe the method of winding the induction cylinder and the direction of the current relative to the commutator brushes:—The wire of the parallel induction helix is substantially endless, and it is wound with reference to obtaining a continuous current. The diagram, Fig. 11, illustrates the manner of winding the wires; the number of parallel coils may be more or less than that shown, but I find the object desired can be attained the best by using an even number of parallel coils longitudinally of the shaft, and an odd number of commutator plates. Starting, say, from the part b of the commutator, the wire passes to the space 4 on one head c^2 to the same space on the other head, then across the head to the space 11, and to the same space on the other head, then across the head to the space 4, and so on until the spaces 4 and 11 are filled with the wire, and when the last turn in 11 has been laid the wire is led to the plate c, and then the spaces 2 and 9 are filled, and the wire from 9 led to d; then 14 and 7, and a connection made

with e; then 12 and 5, connecting with f; then 10 and 3, connecting with g; then 8 and 1, connecting with a; then 6 and 13, connecting with b, the place of beginning.

I wind the wire in such a manner that while the current is continuous, and the current flowing through the whole of it, the current will pass by two wires of the induction coil to one commutator plate, and then away, and will enter by an opposite commutator plate, and pass by two wires out into the coil, and circulate through the same to the other commutator plate. Suppose the springs to rest upon commutator plates a and e the current will flow towards a from wires 1 and 6, and away from e by wires 12 and 7. By following the arrows it will be found that the entire coil is a complete circuit, in which the parallel portions of the wires in the south field of magnetic influence have a current energized in one direction, and in the north field in the other direction, thus obtaining the dynamic effect, and there is no break or pulsation of the current; the springs touch one commutator before leaving another.

As I have heretofore set forth, the maximum economy of illuminating by electricity when using a great number of light giving points is only obtainable by working the resistance in multiple arc, hence it is essential that the generating machines should also be worked in multiple arc. To work a great number of machines in multiple-arc with economy and reliability, it is essential that all should have the same electromotive force, and that means must be devised to prevent injury by burning, to the insulating covering of the induction coil of any machine, should said machine stop for any reason, such as by the breaking of a bolt, because if the wire of the induction coil ceases to be the seat of an electro-motive force, the current from the other machines pass through it and tend to produce sufficient heat to destroy the insulation, and at the same time cause a loss of available energy.

I prevent any such action by the use of the magnet h^2, Fig. 10, which being polarized, is prevented from opening the electric circuit by the direction of the flow of current from the machine when in action, tending to hold its tongue strongly against the contact point c^9; but if the machine should stop and cease to be the seat of an electro-motive force, a current from the other machine tends to pass through the machine in a contrary direction, whereupon the tongue of h^2 is detached from the point c^9, and the circuit opened. Each machine being provided with this apparatus is thus freed from the danger described. An ordinary magnet might replace the polarized one, and a retractile spring used, but the margin for adjustment would be very small.

The resistance of the magnet h^2 is made an exceedingly small fraction of the resistance of the machine to prevent loss of energy.

The field magnets of the machine are energized by supplying them with electricity from thermo electric piles.

Compound condensing steam engines are employed at the large central stations to drive the magneto electric machines, and the heat given off by the surface condensers act upon the thermo electric piles to produce an electric current, and the same is passed through the field of force helices.

The field magnets may all be arranged in multiple arc, and the thermo electric piles arranged in the same manner with appliances, whereby the strength of all the field magnets may be increased or decreased at pleasure, thus increasing or decreasing the electro motive force of the induction bobbins, thus making it easy and convenient by the aid of electrometers at the central stations to counteract the rise and fall in the electro motive force on the main conductors, when the maximum and minimum number of lamps may be working.

I will mention that the electro-motive force is analogous to the pressure in the system of gas lighting, and at dusk when the lamps are rapidly being connected to the circuit, the electrometer will show a slight drop on the electro motive force or pressure, and this may be increased either by increasing the speed of the prime mover, or an increase in the power of the field magnets, the latter method is the one I prefer.

The surface condensers which I employ consist of a great number of iron pipes

whose surfaces are painted with a thick coating of a non-conducting substance. The pipes after painting are about five inches in diameter. Over these are slipped rings of the double sulphide of lead and copper. These rings are cast in a mold, and both the inner and outer edges are either covered or plated with copper. In Figs. 12 and 13, m^1 is the ring or disk of double sulphide; m^4, the copper ring fitted in the hole of m^1; m^2 is a copper ring which fits over the circumference of m^3; to this ring a binding post and strip or wire m^5 is secured, the latter to connect to the next disk. m^7 represents one of the condensing pipes.

m^8, m^9, m^{10}, & m^{11}, a series of disks arranged to give a current. The inner copper of m^9 connects to the outer copper of m^8, and in this manner to many hundreds of disks. Owing to the exceedingly low resistance of these disks, and the considerable electro motive force which they give between low ranges of temperature, very powerful currents are obtained, and nearly as much energy obtained in the form of an electrical current from the waste heat of the engine as can be obtained from the engine itself through the medium of the Faradic machines.

The central stations are intended to light an area of $^1/_4$ of a mile in every direction. The method which I have adopted for conveying the current from the central station to various points consists in laying double wrought pipes, lined with vulcanized rubber known as ebonite, side by side under the flagging stones near the edge of the sidewalk. The pipes are to be in twenty feet lengths, the four ends passing into a cast iron box. The pipes and box are water tight. Fig. 14 is a vertical section of one line of pipe, and Fig. 15 is a perspective view representing the box and two lines of conductors.

For electric lighting purposes I employ a main conductor m, composed of many wires uninsulated from each other, but insulated as a whole from the earth by the ebonite coating of the pipe p; but for telegraphic purposes each of the small wires, instead of acting as parts of one main conductor, are to be insulated from each other by being coated with cotton and afterwards passed through an insulating substance, such as resin, tar, paraffine, or other non-conductor.

By first pulling down pipes p in sections of, say, twenty or twenty five feet, and boxes b between the sections, wires may be introduced sufficient for the purpose at the time, and in the future the number of wires may be increased by drawing others through the pipes. The boxes b allow for introducing or guiding the wires by hand. In practice it will be preferable to employ small pulleys in each box, with a stout cord running backward and forward through the fine of pipe for drawing the wire through each section. The box has a cover c which is bolted to it, and soft rubber or oiled leather washers are placed between the top and the box to prevent air or water leaking into the box. The waterproof material. One end of the system of tubes passes into the central station, and if the other ends are closed a vacuum may be produced within the whole system of pipes; this will promote the evaporation of any moisture which may have passed into the pipes, but the vacuum will only be required periodically. If the two ends pass into central stations warm dry air may be passed through occasionally to prevent dampness. In the system of electric lighting two lines of pipes are employed on each side of the street, but these may be separate and have independent boxes. I prefer that both lines of pipes on each side of the street should be connected to one range of boxes, as illustrated in Fig. 15. A small pipe s insulated with rubber is connected at right angles to the main pipes, and passes from one of the boxes into the house to be illuminated, and carries the conductor, which may be made of one or more wires. From the other main conductor another small tube s serves to carry the second wire to the house. These wires, entering the house through the meter, are carried into various rooms, and the electric lamps connected in multiple are between the two. The wires forming the main conductors are small, and, as mentioned previously, may be uninsulated and laid loosely together, or insulated with a thin layer of cotton. In the latter case each consumer's wire would be independent, but the economy is greater when the wires are all in contact, as

then, when few lamps are in use, the resistance of the main conductor is relatively small as compared to the lamps. The practice of causing the total resistance of the circuit extraneous to the generator to be equal to that of the generator almost universally prevails, and by which the maximum effect is obtained, is very wasteful of energy, for by thus arranging the resistances fifty per cent. of the energy is lost in the machine itself, whereas if the exterior resistance is four times greater than the machine the capacity of the machine to translate energy from one to the other is lessened, but of what is translated, owing to the changed conditions, eighty per cent. may be utilized. For this reason I so arrange the resistance of the main conductors that they should be but one tenth of the total resistance of all the lamps, and the resistance due to the generating machines is kept down by keeping in multiple are a greater number of machines than is necessary to supply all the lights which may happen to be in circuit at the time.

I claim as my Invention,—

First. The combination with a sealed vacuum chamber made of a glass vessel of a continuous incandescent conductor wound upon a bobbin of infusible material, substantially as set forth.

Second. The method herein described of preparing metals and metallic conductors for electric lamps or burners, consisting in freeing the metallic conductors of gases in a vacuum, and then hermetically sealing the surrounding air tight transparent case, substantially as specified.

Third. In an electric lamp, the combination with a sealed transparent vacuum case of a bobbin of pyroinsulated wire wound upon an infusible substance, substantially as specified.

Fourth. In combination with an electric light and the circuits thereof, two electro magnets, one of which is caused to revolve, a governor operated by the speed, and a circuit regulator controlled by the governor, whereby the uniformity of the current passing to the light is maintained, substantially as set forth.

Fifth. In combination with an electric light, an adjustable circuit regulator composed of the insulated springs connected with the circuit wires, a contact block upon which said springs rest, and a governor lever l to regulate the pressure of the contact springs upon the contact block, substantially as set forth.

Sixth. The process of molding sticks of pulverulent material, consisting in filling the mold with the material to be compressed, and then compressing the mass by successive operations by means of a plunger and plunger sections, substantially as described.

Seventh. The divided mold f^1 and block e^2 in combination with the plunger a^2 and plunger sections l^5, substantially as and for the purposes set forth.

Eighth. The combination in a magneto electric machine of the helix of wire b^3 and the wires e^4, wound and connected to the commutator blocks i^2 as described, and forming a parallel induction coil that occupies the space and revolves between the poles of the field magnet, substantially as set forth.

Ninth. The combination in a magneto electric machine of the magnetic cylinder, composed of the helix b^5 surrounded by the parallel induction coil e^5, and revolving between the poles of the field magnet, the commutator i^3, springs d^3 and d^3, and circuit connections, substantially as set forth.

Tenth. In a magneto electric machine, a parallel induction coil, the wires of which are wound substantially as shown in Fig. 11, and commutator connections to the wires, whereby the current is taken off from the parallel induction coil at two points in opposite directions, substantially as set forth.

Eleventh. The cylinder b^3, of wood or similar material, with the iron heads b^5 and intervening helix of wire b^8 in combination with the disks e^3 of non-conducting material, and the induction helix e^6 wound lengthwise and into notches in the edges of the insulating disks, substantially as set forth.

Twelfth. A polarized electro-magnet in the multiple arc circuit of the magneto electric machine, for opening the circuit to the machine to which it is connected in case of derangement of said machine.

Edison's Improvements in Apparatus for Developing Electric Currents, &c.

Thirteenth. The thermo-electric piles, connected as set forth upon the condensing pipes of an engine, in combination with the magneto electric machine, substantially as set forth.

Fourteenth. The combination with the electric conductors M of metallic tubes lined with hard rubber or similar non conducting substance, substantially as set forth.

Fifteenth. The metallic tubes lined with non-conducting material, such as hard rubber, in combination with metallic boxes B lined with similar material, and uniting the tubes and the conductors passed through such tubes, substantially as set forth.

Sixteenth. An induction bobbin nearly surrounded by the poles of the field magnet, and the combination therewith of an abnormally large field magnet, which shall be in proportion to the size of the pole-pieces, as described, for obtaining a powerful electro-motive force in the wires of the revolving bobbin without great loss of energy, as set forth.

In witness whereof, I have hereunto set my hand and seal, this Twenty fifth day of November, A.D. 1879.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
S. L. Griffin, of Menlo Park, N. J.
Wm. Carman, of Menlo Park, N. J.

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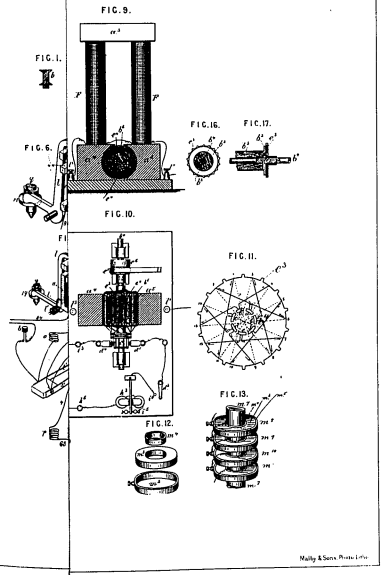

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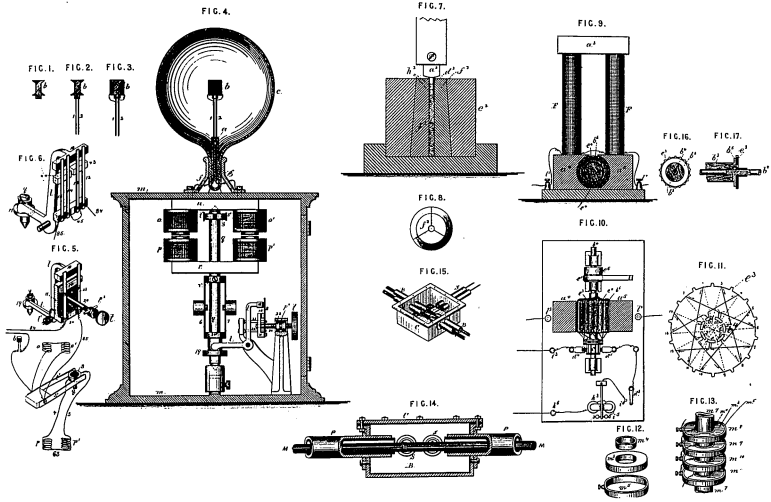

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A.D. 1879, 20th *September.* N° 3794.

Apparatus Employed in Connection with Telephones.

LETTERS PATENT to Arnold White, of Queen Victoria Street, in the City of London, for the Invention of "IMPROVEMENTS IN APPARATUS EMPLOYED IN CONNECTION WITH TELEPHONES FOR THE PURPOSE OF NOTIFYING AND OF FACILITATING AND OBTAINING INTERCHANGEABLE COMMUNICATION BETWEEN TELEPHONIC CIRCUITS." A communication from Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

Sealed the 12th December 1879, and dated the 20th September 1879.

PROVISIONAL SPECIFICATION left by the said Arnold White at the Office of the Commissioners of Patents on the 20th September 1879.

ARNOLD WHITE, of Queen Victoria Street, in the City of London, "IMPROVEMENTS IN APPARATUS EMPLOYED IN CONNECTION WITH TELEPHONES FOR THE PURPOSE OF NOTIFYING AND OF FACILITATING AND OBTAINING INTERCHANGEABLE COMMUNICATION BETWEEN TELEPHONIC CIRCUITS." A communication from Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

This Invention relates to improvements in the methods by which two separate electric circuits may be quickly united to form one, and as quickly divided so as to again constitute two distinct circuits. And further, in improvements in electrical annunciators whereby notice is conveyed to an attendant at a central station or other distant point that his attention is required. And further, in the combination of an electrical circuit connecting board and an electrical annunciator for the especial purposes and uses of telephonic exchanges and other stations.

By means of this Invention the following advantages are obtained:—

1st. Condensation of a large number of wires in a small space, thus offering extraordinary facilities for rapid cross connections.

2nd. Economical construction.

3rd. Enabling one attendant to attend to a larger number of wires than by the methods heretofore in use.

4th. The method whereby the number or name of the station requiring attention is exposed to the attendant as well also as the superior simplicity and effectiveness of the apparatus.

[*Price* 6*d.*]

White's Improvements in Apparatus Employed in Connection with Telephones.

In carrying out this Invention the apparatus is constructed and arranged in the following manner:—

A series of two or more electro magnets are affixed to a parallel bar supported within a frame; there may be one or more rows of these magnets one above the other, or otherwise arranged. Attached to a cast metal frame which supports each electro magnet is an angle piece, which serves the double purpose of providing a means for securing the whole to the face of the parallel bar and of projecting a fixture, to which is attached the device for disclosing a number, name, or other sign indicative of the particular magnet in action. This device consists of a small metal shutter, hinged at the bottom, so that when in an upright position it conceals the sign character, but when released and permitted to fall it uncovers it. The sign may be either upon the reverse face of the drop itself or upon the face of a stationary support immediately behind it when it is in an upright position. The drop is held in an upright position by means of a niche or other device affixed to or upon the end of an extension of the armature of the electro-magnet, and upon the drop the extension is pivotted near its junction with the armature in such a manner that when the armature is depressed by the attraction of the magnet the extended arm is raised and the drop is released from the niche and allowed to fall. In order to reduce the friction between the arm and the drop to a minimum the drop is brought as near as possible to an upright position without reaching a dead centre, from which it could not move by its own gravitation.

The circuit connecting board is supported within the same frame as the electro-magnets and immediately underneath them, and consists of a series of metal upright and horizontal bars so arranged that the upright bars lie across the face of the horizontal bars without being in contact. This is effected by setting them into grooves cut in the face of a wooden or other nonconducting frame, which grooves are deeper for the horizontal than for the upright bars.

In order that the surfaces of both may present one common plane the horizontal bars are cast with projecting lugs of a height equal to the thickness of the upright bars, and of a thickness a trifle less than the space between the upright bars. In this manner two series of bars, one upright and one horizontal, are laid across each other and made to present one common plane without being in actual contact. Holes are then drilled (for the insertion of a metal pin) at every point of crossing of the two series of bars, the object being by the insertion of the pin at will to obtain metallic connection between any two uprights.

The function of the horizontal bars is simply to intersect or join together by the aid of the pin any two of the uprights.

It is apparent that this relative position may be changed and the uprights made to serve as the connection for any two horizontals.

The electrical operation of this telephone combination of annunciator and interconnecting bars will appear from the following description of the arrangement of the circuit:—

The conducting wire conveying the electro currents from the distant station is brought to a small screw cup attached to the top of the frame, and passes from thence by means of fine insulated wires directly to one end of the electro magnet of the annunciator, and from the other end to the top of an upright bar, and traversing this intersects one of the horizontal bars by means of the metal pin, this particular horizontal bar being connected by wire with the earth; thus the circuit is complete from the line to the earth through the annunciator magnet and upright bar, each electro magnet and upright bar serving for a separate line.

If now it is desired to join electrically any two telephone lines it is only necessary to remove the pins of each from the point of junction with the earth connected horizontal bar, and insert them at the point of junction of their respective uprights and a free horizontal.

It will be seen that the two lines which are thus made one electric circuit continue to pass thro' their respective annunciators, and it is only necessary for either distant station to transmit an electric pulsation from their signal batteries or

White's Improvements in Apparatus Employed in Connection with Telephones.

machines to operate the annunciators, and thus signify that they have finished and wish their wires separated from each other and reconnected with the earth bar, the annunciator drops previously thrown down by the original signals having been meanwhile restored to their upright position by the attendant. The circuits may be made in many ways through the electro magnets and bars, but the one hereinbefore described is found to be convenient in practice.

It is of course apparent that when A wishes to be put in communication with B he has but to signal to the attendant, who connecting his telephone in circuit inquires his wishes. Upon receiving the response he immediately connects A and B, as before described; A then calls B direct, B responding affects the annunciators as well.

The cessation of all movement in the armatures of the electro magnets is the signal to the attendant that A and B are now talking. He then restores the drops to position and awaits their simultaneous dropping as his signal to separate them.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Arnold White in the Great Seal Patent Office on the 19th March 1880.

ARNOLD WHITE, of Queen Victoria Street, in the City of London. "IMPROVEMENTS IN APPARATUS EMPLOYED IN CONNECTION WITH TELEPHONES FOR THE PURPOSE OF NOTIFYING AND OF FACILITATING AND OBTAINING INTERCHANGEABLE COMMUNICATION BETWEEN TELEPHONIC CIRCUITS." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

The said Invention relates to improvements in the methods by which two separate electric circuits may be quickly united to form one, and as quickly divided so as to again constitute two distinct circuits. And further, to improvements in electric annunciators, whereby notice is conveyed to an attendant at a central station or other distant point that his attention is required. And further, in the combination of an electric circuit connecting board, and an electric annunciator for the especial purposes and uses of telephonic exchanges and other stations.

By means of the said Invention the following advantages are obtained:—

First. Condensation of a large number of wires in a small space, thus offering extraordinary facilities for rapid cross connections.

Second. Economical construction.

Third. Enabling one attendant to attend to a larger number of wires than by the methods heretofore in use.

Fourth. The method whereby the number or name of the station requiring attention is exposed to the attendant, as well also as the superior simplicity and effectiveness of the apparatus.

In carrying out the said Invention the apparatus is constructed and arranged in the following manner, reference being made to the Sheet of Drawings hereunto annexed, in which Figure 1 represents a front elevation of the apparatus, and Figure 2 is a transverse vertical section of the same.

To a bar A supported within a frame B is affixed a series of two or more electro magnets C, by means of cast metal frames D and screws.

There may be one or more rows of these magnets one above the other, or otherwise arranged. The Drawing represents two rows of electro magnets C, carried respectively by two bars A, A, arranged one above the other, each row containing 12 electro magnets. The metal frames D which support the electro magnets form angle pieces which serve the double purpose of providing a means for securing the electro magnets to the face of the bars A, and of carrying a device for disclosing a number, name, or other sign indicative of the particular magnet in action.

This device consists of a small metal drop or shutter *a* hinged at the bottom *b*, so that when in an upright position it conceals the sign or character, but when released and permitted to fall it uncovers it. The sign may be either upon the reverse face of the drop itself or (as is assumed in the example illustrated) upon the face of a stationary support *c* immediately behind the drop *a*, or when it is in an upright position. The drop is held in an upright position by means of a niche or other device affixed to or upon the end of an extension *d* of the armature *e* of the electro magnet, and upon the drop the extension *d* is pivotted at *f*, near its juncture with the armature *e* in such a manner that when the armature is depressed by the attraction of the magnet, the extended arm *d* is raised, and the drop is released from the niche and allowed to fall. In order to reduce the friction between the arm *d* and the drop to a minimum, the drop is brought as near as possible to an upright position without reaching a dead centre, from which it could not move by its own gravitation.

In the Drawing, Figure 1, the drops of the eighth and seventeenth electro magnets are represented as down, exposing the numbers 8 and 17 respectively, the other drops being represented in their raised position, concealing their respective numbers.

The apparatus hereinbefore described constitutes an electric annunciator, which may be used for conveying notice to an attendant at a central station or other distant part that his attention is required.

The circuit connecting board which forms another part of the said Invention is supported within the same frame as the electro magnets, and immediately underneath them. It consists of a series of metal upright bars E, and of metal horizontal bars F so arranged that the upright bars lie across the face of the horizontal bars without being in contact with them; this is effected by settling the horizontal bars upon the face of a wooden or other non-conducting frame G, and supporting the upright bars upon intervening bars H of wood or other nonconducting material made of a suitable height.

In order that the surfaces of both the upright bars E and the horizontal bars F may present one common plane, the upright bars are let into recesses in the horizontal bars slightly exceeding in width the width of the upright bars. In this manner two series of bars, one upright, and one horizontal, are laid accross each other and made to present one common plane without being in actual contact. Holes *g* are then drilled (for the insertion of a metal pin I) at every point of crossing of the two series of bars, the object being by the insertion of the pin at will to obtain metallic connection between any two uprights. The function of the horizontal bars is simply to intersect or join together by the aid of the pin any two of the uprights. It is apparent however that the converse of this arrangement may be adopted, that is to say, that the uprights may be made to serve as the connection for any two horizontals.

The electrical operation of this telephonic combination of annunciator and inter connecting bars or electric circuit connecting board will appear from the following description of the arrangement of the circuits:—

Let it be assumed that the lowest horizontal bar of the series is connected with earth by means of a wire *h*, and that the pins I are inserted in the holes in this bar (some of the pins are however represented as removed in the Drawing). Taking the first upright bar as an example of the operation of the whole, the conducting wire *i* conveying the electric currents from the distant station is brought to a small binding screw *k* attached to the top of the frame, and passes thence by means of fine insulated wire *l* directly to one end of the electro magnet of the annunciator, and from the other end (by a connection with a binding screw *m*) to the top of the upright bar, and traversing this intersects the lowest horizontal bar by means of the metal pin, this particular horizontal bar being connected by wire with the earth, as before mentioned. The circuit is thus complete from the line to the earth through the annunciator magnet and upright bar. A similar arrangement is adopted in the case of all the electro magnets and upright bars, each electro magnet and upright bar serving for a separate line. One of the horizontal bars (*viz.* the seventh in the example assumed) is connected by a wire *n* with a telephone K, in proximity to the apparatus in order that the attendant at the central station may be able to communicate with any one of the twenty four telephonic lines connected with the apparatus. If now it is desired to join electrically any two telephonic lines, it is only necessary to remove the pins of each from the points of junction with the earth-connected horizontal bar (the lowest bar in the example assumed), and insert them at the point of junction of their respective upright bars, and a free horizontal bar and the two lines are thus made one electric circuit whilst continuing to pass through their respective annunciators.

In order that the mode of using this combined electric annunciator and electric circuit connecting board for the purpose of telephonic exchanges and other central stations may be fully understood, let it be assumed that at a distant station, say, for example, one connected with No. 8 electric magnet wishes to communicate with

White's Improvements in Apparatus Employed in Connection with Telephones.

B at another distant station, say, for example, one connected with No. 17 electro magnet,

A first signals to the attendant at the central station or exchange by sending an electric pulsation from its signal battery or machine to operate the annunciator, and the drop of No. 8 magnet falls displaying the figure 8, as shown in the Drawing, Figure 1. The attendant then removes one of the pins from the lowest horizontal bar, and places it in the hole at the point of intersection of No. 7 horizontal bar with No. 8 upright bar, whereby No. 8 line is placed in circuit with the telephone at the exchange. The attendant next enquires of A his wishes, and receiving a response that he wishes to be connected with No. 17 line, the attendant places the pin corresponding to No. 8 in the hole at the point of intersection of No. 8 upright bar with one of the free horizontal bars, (the second in the example assumed) and places the pin corresponding to No. 17 in the hole at the point of inter section of No. 17 upright bar with the same horizontal bar. Lines Nos. 8 and 17 are then in circuit, and A calls B direct, B responding affects the annunciator, and the drop of No. 17 falls. The apparatus is then in the condition indicated in the Drawing. The cessation of all movement in the armatures of the electro magnets is the signal to the attendant that A and B are now talking, he then restores the drops to their normal position and awaits their simultaneous dropping as his signal to separate the two lines by restoring the two pins to their respective places on the lowest horizontal bar.

It will be understood that if required any other or all of the lines may be similarly connected in pairs at the same time.

When a greater number of lines than that provided for in the example of apparatus illustrated is required to be connected with the exchange, an additional set of electro magnets may be provided at the side of those shewn, and the upright bars E may be extended downwards, as represented at E^1, and an additional set of horizontal bars be provided below the others, as indicated at E^2, in Figure 1.

Having now described and particularly ascertained the nature of the said Invention, and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that what I consider to be novel and original and therefore claim as the Invention secured to me by the hereinbefore in part recited Letters Patent is,—

First. The general construction and arrangement of electric circuit connecting board, whereby any two separate electric circuits may be quickly united to form one, and as quickly divided so as to again constitute two distinct circuits, substantially as hereinbefore described.

Secondly. The general construction and arrangement of electric annunciator, substantially as and for the purpose hereinbefore described.

Thirdly. The combination of an electric circuit connecting board, and an electric annunciator, both constructed and arranged substantially in the manner and for the purpose hereinbefore described.

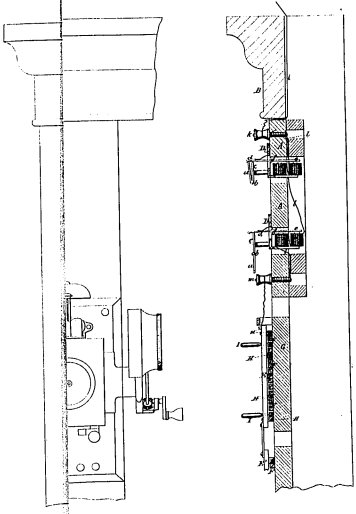
In witness whereof, I, the said Arnold White, have to this my Specification set my hand and seal, this Eleventh day of March, One thousand eight hundred and eighty.

ARNOLD WHITE. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationary Office.
1880.

(1 SHEET)

FIG. 2.



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A.D.1873. Sep. 20. No. 3794.
White's Specification.

(1 Sheet)

FIG. 1.

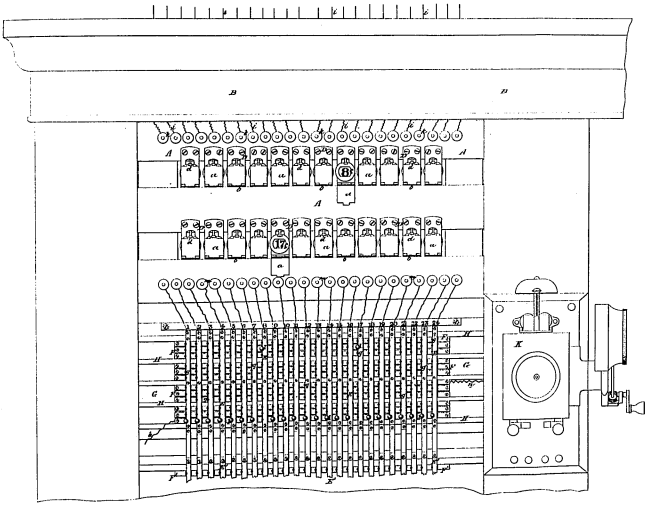
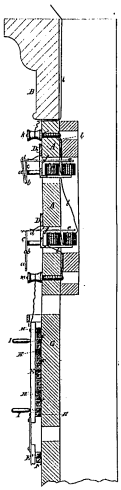


FIG. 2.



Malby & Sons, Photo-Litho.

London. Printed by George Edward Eyre and William Spottiswoode.
Printers to the Queen's most Excellent Majesty 1873.

A.D. 1879, 10th *November*. N° 4576.

Electric Lamps.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

Sealed the 6th February 1880, and dated the 10th November 1879.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 10th November 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

It is necessary to practically subdivide the electric light into a great number of luminous points, so that lamps connected in multiple may be employed without the necessity of using conductors of great size for the current to the lamps. It is essential that the lamps should be of great resistance. In the Provisional Specification of Patent dated June 17th, 1879, No. 2402, I have set this forth, and obtained lamps of great resistance by employing long lengths of platinum or metallic wires pyroinsulated, and wound in such a manner that but small radiating surface is exposed to the air, although a great length of wire is used.

My present Invention relates to lamps of a similar character, except that carbon threads or strips are used in place of metallic wires. I use a block of glass, into which are sealed two platinum wires. These wires serve to convey the current to the electric lamp within a bulb, which is blown over the lamp and united to the glass block. The bulb is exhausted of air to about one millionth of an atmosphere. Upon the ends of these wires are two clamps that secure two other platinum wires. The burner consists of a filament or thread of carbon, preferably coiled, with the ends secured to the platinum wires, the whole being made as follows:—

Fibrous material, such as paper, thread, wood, or any vegetable or animal matter which can be carbonized, has the ends secured to platinum wires, the fibre is wound in such a shape as to expose the least amount of surface to radiation, such as in a helix or spiral. The helix is secured to the platinum wires by plastic carbon, and the whole is placed in a closed vessel free from air, and subjected to a heat sufficient to fully carbonize the fibre, and leave nothing but carbon. At the

[*Price* 6*d.*]

same time the effect of the carbonization is to lock the carbon to the platinum wire, and make good connection.

These wires are secured by the clamps to the two platinum wires in the bulb, and the bulb is exhausted of air and sealed. Lamps of one hundred ohms resistance may be made in this manner, from which light from the incandescent carbon is obtained. The destruction of the fragile carbon by oxidation is prevented by the high vacuum, which is obtained before sealing the glass bulb.

Previously to my Invention carbon sticks have been used, but they have only had a resistance of three or four ohms, and none have been used in vacuum bulbs composed entirely of glass, except the leading wires, hence the difficulties of sealing leading wires into glass, which would convey a current of sufficient strength to a lamp of but three or four ohms resistance is too great to make such a lamp successful, but when the resistance of the lamp is 100 ohms or more the leading wires can be very small, as they will then be a small factor in the total resistance of the lamp, and will not heat so as to crack the glass.

Lamp black, which has been placed in sealed crucibles, and subjected to a white heat for several hours, may be kneaded with tar until it reaches such a consistency as to allow its being rolled out on flat plates to very thin wires, which are sufficiently flexible to allow of coiling into helices; after they are rolled out to the proper length and size they are coated with a non-carbonizable powder of liquid, and wound or coiled.

The two ends are increased in size and secured to platinum wires, the whole is then subjected to heat in a closed tube, and the volatile constituents of the tar driven off and the balance carbonized, thus making a solid and homogeneous coil, which can be then united to the leading wires of the lamp, and a glass bulb blown over it and exhausted of air, and the lamp is then ready for use. The non-carbonized material prevents the spirals from touching each other until the whole has so stiffened sufficiently to remain in its position.

To assist in more rapidly manufacturing these spirals I sometimes wind the flexible carbon wires between metallic spirals, which after the carbonization of the tar are eaten away by acids, thus leaving the carbon intact. I also sometimes roll a thread within the compound of carbon and tar, so as to allow of greater convenience in handling the same, and the flexible carbon filament is not so liable to crack by its own weight in the act of winding.

To increase the resistance of the lamp black tar compound I sometimes work it into a volatile powder, such as powdered camphor, oxide zinc, but to make the light insensitive to variations of the current a considerable mass of matter should be used, in order that the specific heat of the lamp may be increased, so that it takes a long time to reach its full brilliancy, and also to die away slowly. To do this it is better to have the carbon as homogeneous as possible, and obtain the requisite resistance by employing a filament several inches long, and winding the same in a spiral form, so that the external radiating surface shall be small.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 10th May 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

The object of this Invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance so as to allow of the practical subdivision of the electric light.

The Invention consists in a light giving body of carbon wire, or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The Invention further consists in placing such light giving body of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere.

The current is conducted into the vacuum bulb through platina wires sealed into the glass.

The Invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires, and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms resistance placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading wires and the carbon has been obtained by clamping the carbon to the metal.

The leading wires have always been large, so that their resistance shall be many times less than the burner; and in general the attempts of previous persons has been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple are without the employment of main conductors of enormous dimensions, that owing to the low resistance of the lamp the leading wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented, hence the carbon is consumed because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass, and high in electrical resistance.

In the use of a gas in the receiver at the atmospheric pressure, which, although not attacking the carbon, serves to destroy it in time by "air washing" or the attrition produced by the rapid passage of the air over the slightly coherent highly heated surface of the carbon.

I have reversed this practice. I have discovered that even a cotton thread properly carbonized, and placed in a sealed glass bulb exhausted to one millionth of an atmosphere, offers from one hundred to five hundred ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral, and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, that as much as two thousand ohms resistance may be obtained without presenting a radiating surface greater than three sixteenths of an inch; that if such fibrous material be rubbed with a plastic compound composed of lamp-black and tar, its resistance may be made high or low according to the amount of lamp-

Edison's Improvements in Electric Lamps.

black placed upon it. I have also discovered that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seven one thousandths, 7/1000, of an inch in diameter, and over a foot in length, and the same may be coated with a non-conducting non-carbonizable substance, and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form. I sometimes roll a thread within the compound of lamp-black and tar, so as to allow of greater convenience in handling the same; and the flexible carbon filament is not so liable to crack by its own weight in the act of winding.

To increase the resistance of the compound of lamp black and tar I sometimes work into it a volatile powder, such as powdered camphor, oxide zinc, but to make the light insensitive to variations of the current a considerable mass of matter should be used in order that the specific heat of the lamp may be increased, so that it takes a long time to reach its full brilliancy and also to die away slowly.

To do this it is better to have the carbon as homogeneous as possible, and obtain the requisite resistance by employing a filament several inches long and winding the same in a spiral form so that the external radiating surface shall be small. All these forms are fragile and cannot be clamped to the leading wires with sufficient force to ensure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be molded around it that in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps, hence the light giving body and the platina wires are connected and ready to be placed in the vacuum bulb.

When fibrous material is used the plastic lamp black and tar is employed to secure it to the platina wires before carbonizing. By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the light giving body, hence will not heat and crack the sealed vacuum bulb.

Platina can only be used, as its expansion is nearly the same as that of glass. By using a considerable length of carbon wire and coiling it in such a manner that only a small portion of its entire surface radiates light, I can raise the specific heat of the whole and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial as it shows the least unsteadiness of the current by the flickering of the light, but if the current is steady the defect does not show. I have carbonized and used cotton and linen thread, wood-splints, paper coiled in various ways, also lamp-black, plumbago, and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters, each wire however is to be uniform in size throughout. If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading wires by plastic carbonizable material and the whole placed in the carbonizing chamber. The copper which has served to prevent distortion of the carbon thread is afterwards eaten away by nitric acid, and the spiral soaked in water and then dried and placed in the glass holder, and a glass bulb blown over the whole with a leading tube for exhaustion by a mercury pump. This tube when high vacua has been reached is hermetically sealed.

With substances which are not greatly distorted in carbonizing they may be coated with a non-conducting non-carbonizing substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the Drawing Fig. 1 shows the lamp sectionally. *a* is the carbon spiral or thread; *c*, *c*¹, are the thickened ends of the spiral formed of the plastic compound of lamp-black and tar; *d*, *d*¹, are the platina wires; *h*, *h*, are the clamps which serve to connect the platina wires cemented in the carbon with the leading

Edison's Improvements in Electric Lamps.

wires *x*, *x*, sealed in the glass vacuum bulb; *e*, *e*, are copper wires connected just outside the bulb to the wires *x*, *x*; *m* is the tube, shown by dotted lines leading to the vacuum pump, which tube is hermetically sealed near the glass bulb after the bulb has been exhausted of air, as aforesaid.

Fig. 2 represents the plastic material before being wound into a spiral.

Fig. 3 show the spiral after carbonization ready to have a bulb blown over it.

I claim as my Invention,—

First. An electric lamp for giving light by incandescence consisting of a filament of carbon of high resistance, made as described and secured to metallic wires, as set forth.

Second. The combination of a carbon filament within a receiver made entirely of glass, through which the leading wires pass and from which receiver the air is exhausted, for the purposes set forth.

Third. A coiled carbon filament or strip arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light, as set forth.

Fourth. The method herein described of securing the platina contact wires to the carbon filament and carbonizing of the whole in a closed chamber, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 20 day of April, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 140, Nassau St., N.Y.
GEO. T. PINCKNEY, " " " "

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.

A.D. 1879. Nov. 10. N° 4576.
EDISON'S SPECIFICATION.

(1 SHEET)

FIG. 1.

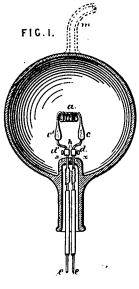
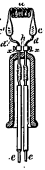


FIG. 2.

FIG. 3.



Malby & Sons, Photo-Litho.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1880.

A.D. 1879, 15th *December*. N° 5127.

Electric Lamps, &c.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENTS IN ELECTRIC LAMPS AND IN THE METHOD OF MANUFACTURING THE SAME."

Sealed the 20th February 1880, and dated the 15th December 1879.

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 15th December 1879.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN ELECTRIC LAMPS AND IN THE METHOD OF MANUFACTURING THE SAME."

In a former application made by me for Letters Patent in Great Britain an improvement in electric lamps is set forth, wherein a filament of carbon is enclosed in a glass bulb and the atmosphere removed as nearly as possible, and the carbon is brought to incandescence by an electric current to form the lamp.

My present Invention relates to an improvement in the process of manufacturing the carbon filament and the means for securing the same to the conductors.

I make use of paper of the desired thickness, as free as possible from foreign substances or adulterations, and for this purpose I prefer and use bristol board. With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

A number of these pieces of paper are laid flat wise in the bottom of a mould, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mould a piece of tissue paper is interposed between each one and the next. A cover is used to close the mould, and the mould is raised very gradually to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away, and at the same time the mould retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted, as it would be likely to do if the heat was applied suddenly or the light weight dispensed with.

The mould is now placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually.

[*Price* 6*d*.]

The carbon filaments will be found to be smaller than the cardboard blanks, and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner.

The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current. The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamp and the carbon will be less than the resistance of the carbon filament, hence but little heat will be developed at the clamps. In ordinary electric lamps the large carbons do not offer much resistance to the electric current, and unless the clamps are very firmly pressed upon the carbon the current meets with considerable resistance at the clamps, and hence heat is developed at such clamps.

The clamps that I prefer are made of a steel spring tipped at the ends with platina or similar metal. The spring is bent into a circle or bow, and the ends crossed and turned back towards each other, similar in shape to the figure 8, with the opening for the carbon between the spring ends at the upper part; the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the lamp instead of being lessened, as it would be if the wire was only bent into a single bow.

The spring clamps are connected to the platina or similar conducting wires by clips, and the platina wires pass through the glass of the globe or bulb that contains the lamp; the air is to be exhausted from the bulb by any suitable means, and it is preferable to exhaust said air as perfectly as possible, say to the one eight hundred thousandth of an atmosphere.

The lamps are suspended or supported in any convenient manner and the electric current from a magneto electric machine or other source of electricity is passed through the lamp and brings the carbon filament to a high incandescence, and the lamp is very durable, and a large number of such lamps can be placed in the electric circuit in multiple arc or otherwise, as desired.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 15th June 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN ELECTRIC LAMPS AND IN THE METHOD OF MANUFACTURING THE SAME."

In British Letters Patent, No. 4576 granted to me November 10, 1879, an improvement in electric lamps is set forth wherein a filament of carbon is inclosed in a glass bulb and the atmosphere removed as nearly as possible, and the carbon is brought to incandescence by an electric current to form the lamp. My present invention relates to an improvement in the process of manufacturing the carbon filament, and in the means for securing the same to the conductors. I make use of paper of the desired thickness, as free as possible from foreign substances or adulterations, and for this purpose I prefer and use "bristol board." With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions. A number of these pieces of paper are laid flatwise in the bottom of a mold, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mold a piece of tissue paper is interposed between each one and the next. A cover is used to close the mold, and the mold is raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away, and at the same time the mold retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted, as it would be likely to do if the heat was applied suddenly or the light weight dispensed with. The mold is now placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. The carbon filaments will be found to be smaller than the cardboard blanks, and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner. The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current. The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamps and the carbon will be less than the resistance of the carbon filament, hence but little heat will be developed at the clamps. In ordinary electric lamps the large carbons do not offer much resistance to the electric current, and unless the clamps are very firmly pressed upon the carbon the current meets with considerable resistance at the clamps and hence heat is developed at such clamps. The clamps that I prefer are made of a steel spring tipped at the ends with platina or similar metal; the spring is bent into a circle or bow and the ends crossed and turned back towards each other, similar in shape to the figure 8, with the opening for the carbon between the spring ends at the upper part; the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the lamp instead of being lessened, as it would be if the wire was only bent into a single bow. The spring clamps are connected to the platina or similar conducting wires by clips, and the platina wires pass through the glass of the globe or bulb that contains the lamp; the air is to be exhausted from the bulb by any suitable means, and it is preferable to exhaust said air as perfectly as possible, say to the one eight hundred thousandth of an atmosphere. The lamps are suspended or supported in any convenient manner and the electric current from a magneto

Edison's Improvements in Electric Lamps, &c.

electric machine or other source of electricity is passed through the lamp and brings the carbon filament to a high incandescence, and the lamp is very durable, and a large number of such lamps can be placed in the electric circuit in multiple arc or otherwise, as desired.

In the Drawing,—

Fig. 1 is a vertical section of the lamp complete.

" 2 is a side view in larger size of the clamping device.

" 3 is a section at the line *x*, *x*, in still larger size.

" 4 is the wire forming one of the clamps before it is bent up to shape.

" 5 is the paper blank before it is carbonized, and

" 6 is a section of the box.

The blank *a* is cut out of paper material, such as "bristol-board," in the proper shape, the form shown in Fig 5 is preferred; the same is laid in the metal mold *b*, and when several are laid one on the other pieces of thin paper are introduced between. The weight *d* is laid on these, it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d* is of gas retort carbon. The cover *c* is placed on the mold and secured, and the mold is heated as before described.

The carbon filament *i* forms the lamp when rendered incandescent by the electric current passed through it. The clamp is made of the wire *h*, at the ends of which are tips or small rivets *r* of platina or similar material. The wire is bent up and crossed, as shown, so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp. The wire is attached to a small stock *o*, into which the conducting wire *l* passes and is clamped.

The conductors for the two ends of the carbon are inserted into the glass and the latter intimately melted around them, the carbon and clamps are connected to the wires and the parts introduced within the neck of the bulb *m* and the glass melted at *v*; the air is exhausted from the globe by the tube *t* that passes away, as shown by dotted lines, and the tube melted together while the vacuum is maintained.

The lamp is ready for the conductors to be attached to it, and the carbon is rendered incandescent by the current that passes through the same. It is durable as there is nothing to combine with the carbon, and it is substantially indestructible.

I claim as my Invention,—

First. An electric lamp formed of carbonized paper.

Second. The method herein specified of manufacturing carbons for electric lights, consisting in exposing the filament of paper to the action of heat in a mold to drive off the volatile portions and carbonize the paper, substantially as set forth.

Third. A carbon for electric lights made as a filament with the ends broader for the clamping devices that connect the conductors.

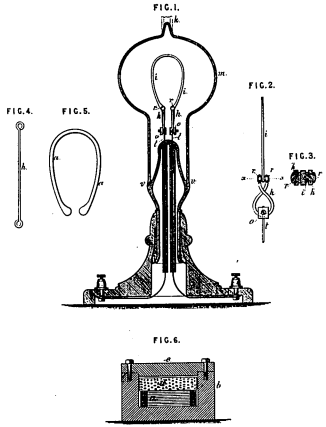
Fourth. The clamp for the carbon of an electric lamp composed of a bow or elliptical spring with the ends crossing each other and receiving between them the carbon, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Eighteenth day of May, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
STOCKTON L. GRIFFIN,
JOHN F. RANDOLPH.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.



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LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1880.

A.D. 1879, 31st DECEMBER. N° 5335.

Telephones.

LETTERS PATENT to Arnold White, of Queen Victoria Street, in the City of London, for the Invention of "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

Sealed the 19th March 1880, and dated the 31st December 1879.

PROVISIONAL SPECIFICATION left by the said Arnold White at the Office of the Commissioners of Patents on the 31st December 1879.

ARNOLD WHITE, of Queen Victoria Street, in the City of London. "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

This Invention relates to improvements in and connected with the receiving apparatus of telephones, in respect of which Letters Patent were granted to the said Thomas Alva Edison, dated respectively the 30th July 1877, No. 2909, and the 15th June 1878, No. 2396.

According to the first of the said former Letters Patent the receiving apparatus was provided with a frictional surface moved by power, and acting in connection with the electric current to vibrate a tympan and produce tones corresponding to those actuating the transmitting apparatus. According to the second of the said former Letters Patent the said frictional surface was composed of chalk combined with a chemical substance and kept moistened with water.

Now according to the present Invention it is proposed to dispense with the chemical substance previously employed in combination with the chalk, and to use the latter alone moistened with distilled or pure water.

In carrying out the said former Invention it has been customary to use a metal spring or arm tipped or faced with platinum in contact with the chalk body of the receiving apparatus. Now, according to the present Invention, it is proposed to employ a metal spring or arm tipped or faced with paladium, whereby the degree of frictional variation is increased under the action of a given strength of electric current, and a corresponding augmentation in the volume of sound is obtained.

Another part of the present Invention relates to the arrangement of the connections of the induction coil in which the several parts of the apparatus are placed.

[Price 6d.]

In carrying out this part of the Invention it is found advantageous to place the receiving apparatus in a tertiary circuit in lieu of in the secondary circuit; but it is found that by reason of the presence of two continuous circuits, *viz.*, the primary and tertiary circuits, the full effect of the current from the distant station is not obtained upon the receiving apparatus, a portion of it passing from the secondary to the primary circuit. In order to obviate this defect, a key is placed in the primary circuit, so arranged as to keep that circuit open while the current from the distant station is acting upon the receiving apparatus, the said key being depressed for the purpose of closing the primary circuit when it is desired to actuate the transmitting apparatus. It has been found, however, that upon opening or closing this key a powerful inductive discharge is directed upon the receiving apparatus at the same station, which discharge has a deteriorating effect upon the surface of the chalk body of the receiving apparatus.

According to this part of the present Invention the defect before mentioned is obviated by opening the tertiary circuit prior to the closing of the primary circuit, and closing the tertiary circuit to leave it in condition to be acted upon by a current from the distant station, immediately after the closing of the primary circuit, and also by opening the tertiary circuit prior to the opening of the primary circuit, and closing the tertiary circuit immediately thereafter.

In carrying this part of the present Invention into effect, these conditions are fulfilled by the employment of a single key arranged in the following manner, *viz.*:—One of the wires from the tertiary coil, and one of the wires from the primary coil, are permanently attached to the lever of the key, and the other wire of the tertiary coil is bifurcated, and the ends of its two lengths are provided with contact points placed one at each side of the lever of the key, but at such a distance therefrom as to admit of a third contact point connected with the other wire of the primary coil being brought into contact with the lever of the key while it is passing from one to the other of the two contact points of the bifurcated tertiary wire.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Arnold White in the Great Seal Patent Office on the 14th April 1880.

ARNOLD WHITE, of Queen Victoria Street, in the City of London. "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

The said Invention relates to improvements in and connected with the receiving apparatus of telephones, in respect of which Letters Patent were granted to the said Thomas Alva Edison, dated respectively the Thirtieth July One thousand eight hundred and seventy seven, No. 2909, and the Fifteenth June One thousand eight hundred and seventy eight, No. 2396.

According to the first of the said former Letters Patent the receiving apparatus was provided with a frictional surface moved by power and acting in connection with the electric current to vibrate a tympan, and produce tones corresponding to those actuating the transmitting apparatus. According to the second of the said former Letters Patent the said frictional surface was composed of chalk combined with a chemical substance, and kept moistened with water.

Now, according to the present Invention, it is proposed to dispense with the chemical substance previously employed in combination with the chalk, and to use the latter alone moistened with distilled or pure water.

In carrying out the said former Invention it has been customary to use a metal spring or arm tipped or faced with platinum in contact with the chalk body of the receiving apparatus. Now, according to the present Invention, it is proposed to employ a metal spring or arm tipped or faced with palladium, whereby the degree of frictional variation is increased under the action of a given strength of electric current, and a corresponding augmentation in the volume of sound is obtained.

Another part of the present Invention relates to the arrangement of the connections of the induction coil in which the several parts of the apparatus are placed.

In carrying out this part of the Invention it is found advantageous to place the receiving apparatus in a tertiary circuit in lieu of in the secondary circuit; but it is found that by reason of the presence of two continuous circuits, *viz.*, the primary and tertiary circuits, the full effect of the current from the distant station is not obtained upon the receiving apparatus, a portion of it passing from the secondary to the primary circuit. In order to obviate this defect a key is placed in the primary circuit, so arranged as to keep that circuit open while the current from the distant station is acting upon the receiving apparatus, the said key being depressed for the purpose of closing the primary circuit when it is desired to actuate the transmitting apparatus. It has been found, however, that upon opening or closing this key a powerful inductive discharge is directed upon the receiving apparatus at the same station, which discharge has a deteriorating effect upon the surface of the chalk body of the receiving apparatus.

According to this part of the present Invention the defect before mentioned is obviated by opening the tertiary circuit prior to the closing of the primary circuit, and closing the tertiary circuit to leave it in condition to be acted upon by a current from the distant station immediately after the closing of the primary circuit, and also by opening the tertiary circuit prior to the opening of the primary circuit, and closing the tertiary circuit immediately thereafter.

In carrying this part of the present Invention into effect these conditions are fulfilled by the employment of a single key arranged in the following manner, *videlicet*:—One of the wires from the tertiary coil and one of the wires from the primary coil are permanently attached to the lever of the key, and the other wire of the tertiary coil is bifurcated, and the ends of its two lengths are provided with contact points placed one at each side of the lever of the key, but at such a distance therefrom as to admit of a third contact point, connected with the other wire of the primary coil, being brought into contact with the lever of the key while it is passing from one to the other of the two contact points of the bifurcated tertiary wire.

In order that the said Invention may be perfectly understood, I shall describe a complete set of instruments for the purposes of telephonic communication with the Invention applied thereto, and in so doing shall refer to the several Figures on the accompanying Sheet of Drawings, the same letters of reference in which indicate corresponding parts in all the Figures.

Figure 1 of the accompanying Drawings represents in sectional elevation a general view of the instruments and their connections for the purpose of telephonic communication between two stations, marked respectively No. 1 and No. 2, the transmitters being drawn to their natural size, whilst the other parts of the apparatus are drawn to a scale of one half size.

Figure 2 represents an elevation of one of the receivers, shewn detached with the cover removed, and Figure 3 is a transverse section of the same.

A, A, are the transmitters; B, B, are the receivers; C, C, are the batteries; D, D, are the induction coils, a being their primary circuit (shewn in thick lines) in which the transmitter is placed; b, their secondary circuit (indicated in thick dotted lines), which constitutes the main line, and c, their tertiary circuit (denoted by series of short thick lines and dots) in which the receiver is placed; E, E, are relays, and F, F, are call bells or sounders, d, d, being local circuits (indicated by a series of short fine lines in the Drawing), in which the call bell or sounders are placed.

The transmitter is constructed in the following manner:—

e is a shell of metal (by preference cast iron), on which is secured a disc f of brass (for example) platinized on its top surface f^1, around which disc is arranged a ring g of vulcanite or other suitable non conducting material projecting above the surface of the disc for a sufficient height to form a cup. Into this cup is inserted a button h of carbon (by preference the finest lamp black, moulded and consolidated under pressure), and upon the top of this button is placed another metal disc e^1, platinized upon its surface e^2. The terminal a^1 of the divided portion a^4 of the wire a is connected to the disc i by means of a strip k of platinum, whilst the terminal a^3 of such portion of the said wire is attached to the shell e. The carbon button h, with the metal disc i, is thus interposed in the electric circuit, and it is so arranged as to be susceptible of mechanical influence from the exterior in the following manner:—

On the rim of the shell e is placed a membrane or tympan l of mica or iron (for example), which is held firmly at its edges by the mouth piece m, attached by screws to the shell e, the tympan being thus clamped between the mouth piece and the shell. The tympan is provided with a boss at its centre, through which passes a screw n, the point of which bears upon the disc i faced with nonconducting material. In fitting the parts together, the screw n is turned until the tympan l, the disc i, and the carbon button h are brought into such relationship as to produce a minimum, but actual contact between the surfaces of all, but not to establish the contact to such an extent as to constitute an initial degree of pressure.

The apparatus operates in the following manner:—

By producing sound (say for example, speaking) into the mouth piece m, the tympan l is thrown into vibration, and the effect being transmitted to the disc i, and the carbon button h, their positions in relation to each other are varied, greater or less intimacy of contact being produced between the two surfaces of the carbon button h and the discs i, f, on opposite sides of it. By these means a greater or less number of points in the contiguous surfaces are brought into contact as the tympan is vibrated, whereby the resistance to the passage of the current is varied, and the current passing through the primary circuit a is transformed into an undulatory one; the induced current passing through the secondary circuit or main line b is also converted into an undulatory current, and thence a similar change takes place in the induced current passing through the tertiary circuit c, in which the receiver at the distant station is placed, the undulations of which current exactly correspond to the waves of sound which originally actuated the tympan at the sending station.

The receivers B, B, are constructed in the following manner, reference being had to the general view, Figure 1, and the details, Figures 2 and 3:—

o is a cylinder of chalk, moulded upon a shaft p, which is supported in bearings q, q, attached to the casing r, and is extended beyond the casing, and provided at its outer extremity with a worm wheel s, with which engages a worm s^1 on a spindle t, the latter being provided with a crank handle t^1 for the facility of turning the worm s^1, and thence imparting rotary motion to the chalk cylinder. u is a disc or tympan of mica, which is attached at its edges by the cover v, and screws to the casing r and carries at its centre a strip or arm v^1 of brass faced or tipped with palladium at v^2, which projects over the cylinder o, and is maintained in yielding contact with the chalk by means of an india rubber spring or cushion w, the pressure

of which is regulated by means of a screw w^1. The terminal c^1 of the divided portion c^3 of the tertiary wire c is connected with the brass strip or arm v^1, and the terminal c^2 of such portion of the said wire is connected to one of the bearings q, q, of the shaft p on which the chalk cylinder o is mounted, the chalk cylinder o and the brass strip or arm v^1 are thus in the circuit, so that the electric current is caused to pass from the brass strip or arm to and through the chalk cylinder at the point of contact with the strip or arm. The chalk is moistened with pure or distilled water at long intervals, so as to maintain it in a humid condition, and when the electric current passes, a chemical action is produced on the surface of the cylinder, and among other parts at the point of contact of the strip or arm therewith.

The receipt of an oral communication takes place under the following conditions, *videlicit*:—The crank handle t^1 is turned by hand in either direction at pleasure so as to impart rotary motion to the chalk cylinder whereby the disc or tympan u is drawn forwards or thrust backwards according to the direction in which the cylinder is rotated, when now an undulatory current the result of the actuation of the tympan at the sending station, as hereinbefore described, traverses the tertiary circuit, a variable degree of lubricity in accordance with the undulations of the current is produced on the surface of the chalk, and the metal strip or arm is proportionately released, allowing the tympan to return towards its normal position. This action being continued so long as the cylinder is rotated and the current is passing, the tympan u is caused to vibrate in unison with the tympan of the transmitter at the sending station and audible sounds are produced at x corresponding to the vocal sounds which originally actuated the tympan of the transmitter at the sending station.

The several connections are clearly indicated in the Drawing, the presence of a curve at the point of intersection of two lines denoting that the wires represented pass one behind the other and are not connected with each other.

In using the apparatus the tertiary circuit is opened prior to the closing of the primary circuit, and is closed to leave in condition to be acted upon by a current from the distant station immediately after the closing of the primary circuit, and the tertiary circuit is opened prior to the opening of the primary circuit and closed immediately thereafter. These conditions are fulfilled by the employment of a single key G arranged in the manner shewn in Figure 1 of the Drawings and next hereinafter described.

The wire c^3 of the tertiary circuit c and the wire a^3 of the primary circuit a are permanently attached to the lever y of the key G, and the other wire (c^4) of the tertiary circuit is bifurcated, as shewn at c^5, c^6, and the ends of these two lengths c^5, c^6, are provided with contact points 3, 4, placed one at each side of the lever y of the key G, but at such a distance therefrom as to admit of a third contact point 5 connected with the other wire (a^4) of the primary circuit a being brought into contact with the lever of the key while it is passing from one to the other of the two contact points of the bifurcated tertiary wire. During the normal condition of the apparatus the keys G are in the positions indicated in the Drawing, the primary circuit being open and the tertiary circuit being closed. When now it is required to send a communication from either station, the key G of that station is depressed so as to cause it to leave the contact point 3 of the bifurcated wire c^4 of the tertiary circuit c, and bring it into contact with the contact point 4 of the said wire. By this movement the tertiary circuit is first opened, then the key being brought into contact with the contact point 5 the primary circuit is closed, and finally when the lever of the key arrives at the contact point 4 the tertiary circuit is closed in readiness to be acted upon by a current from the distant station. When the key is released in order to open the primary circuit the lever of the key first leaves the contact point 4, thus opening the tertiary circuit, then leaves the contact point 5, thus opening the primary circuit, and finally arrives at the point 3, thereby closing the tertiary circuit and placing it in a condition to be acted upon by a current from the distant station.

Before sending an oral communication the call bell or sounder F at the distant

station is actuated so as to notify that a communication is about to be sent. This result is obtained by the act of depressing the key H at the sending station, thus completing the secondary circuit whilst isolating the apparatus at the sending station, and exciting the relay E at the distant station; by the action of this relay the local circuit *d* is completed and the bell F is sounded, a notification being thus afforded that a communication is about to be sent. The key H is then released and the key G is operated, and the sender speaks into the mouth piece *m* of the transmitter A, and the speech is heard at the receiver B of the distant station, as hereinbefore explained.

Having now described and particularly ascertained the nature of the said Invention and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that although I have described various devices and arrangements which are necessary or desirable in carrying out the said Invention, yet I make no claim to any of the said devices or arrangements as forming any part of the present Invention, except as hereinafter mentioned, but what I consider to be novel and original, and therefore claim as the Invention secured to me by the hereinbefore in part recited Letters Patent is,—

First. Constructing the frictional surface of the rotary body of the receiver of chalk moistened with pure or distilled water, substantially as hereinbefore described.

Secondly. In a receiver constructed as herein set forth the employment in contact with the surface of the moving chalk body of a metal strip or arm tipped or faced with paladium, substantially as hereinbefore described.

Thirdly. The mode of controlling the opening and closing of the primary and tertiary circuits by the use of a single key, so arranged that the tertiary circuit shall be opened before the primary circuit is closed or opened, and shall be closed immediately afterwards, substantially as and for the purpose hereinbefore described.

In witness whereof, I, the said Arnold White have to this my Specification set my hand and seal, this Twelfth day of April, One thousand eight hundred and eighty.

ARNOLD WHITE. (L.S.)

Witness,
W. B. MERCER,
Clerk,
11, Queen Victoria Street,
E.C.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.

A.D.1879. Dec. 31. Nº 5335.
WHITE'S SPECIFICATION.

(1 SHEET)

Nº 2.

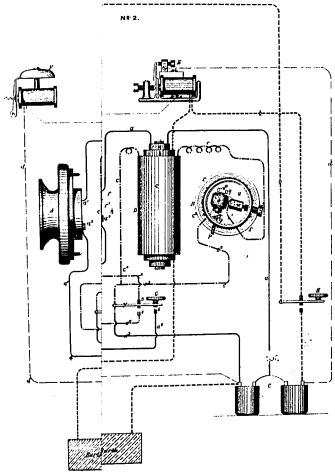

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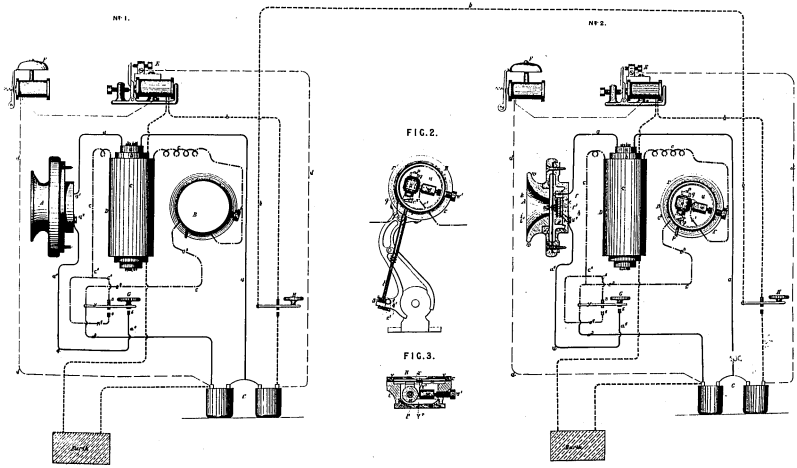
FIG. 1.



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LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1890.

A.D. 1880, *3rd January.* N° 33.

Developing Electric Currents for Electric Lights.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for an Invention of "IMPROVEMENTS IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME IN CIRCUITS THAT PASS TO ELECTRIC LIGHTS OR ELECTRO MAGNETIC ENGINES."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 3rd January 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME IN CIRCUITS THAT PASS TO ELECTRIC LIGHTS OR ELECTRO MAGNETIC ENGINES."

In my system of electric lighting I have proposed in a previous Patent to regulate the pressure or electro-motive force at the central station by varying the strength of the field magnets around the induction bobbins connected to the main conductors.

Any rise or fall in the electro motive force due to putting on or off lamps is to be indicated by an electro meter. I find that an electro dynometer similar to that of Webber, but of high resistance, is an improvement upon the electro meter, owing to its greater reliability. Two of such are used, and connected across the main conductors in multiple arc.

In my system a city is to be divided up into districts; in each district there is a central station, which station is provided with sufficient motive power and electric generators to supply half a mile radius.

At this station I employ, say, five engines, each of 250 horse power; each engine runs by a belt a separate line of shafting. On this shafting is belted, say, 40 electric generators, so that each engine and its system of generators may be considered complete within itself. 2 large rods of copper are conveyed in proximity to all the generators, and connecting levers are arranged so that any generator may be placed across and feed into the two main conductors.

All the generators when connected to the mains are connected in multiple arc, and the field magnet of every generator is so wound, or the pulleys upon its shaft so made that by increase or decrease of speed, or by a weakening or strengthening

[*Price 4d.*]

of the field magnet the electro motive force of the induction may be adjusted to exactly the same electro motive force in all the machines.

I employ several subsidiary electro generators belted on the shaft of the first engine, which are all in use, and the currents from these machines are conveyed by leading wires to the field magnet of all the generators, and serve to keep a constant field. A second series of these subsidiary machines is connected to the shaft of the second engine, and connected in duplicate so as to be used in case of emergency or in case the first engine stops. A switch is provided for changing one subsidiary generator from one set to another set, so that the change can be made gradually. The subsidiary generators are also arranged in multiple arc, but the field magnets of main line generators are so connected that there will be a row of, say, 10 magnets connected in series, and these sets connected in multiple arc. Switches are provided whereby, say, 10 field magnets are disconnected at once, the induction bobbin having previously been disconnected from the mains.

For energizing the field magnets of the subsidiary generators I use a dynamo electric machine, the current from which passes through the field magnets of all the subsidiary generators either in series or in multiple arc.

In this circuit I place a large number of resistance coils of large wire, and subdivided so that each has, say, $\frac{1}{10}$ of an ohm. resistance. A wire between each resistance coil leads to a rotary commutator, which by being turned short circuits a greater or less number of resistance coils, thus increasing or decreasing the strength of the currents in the field magnets of the subsidiary generators; this in its turn increases or decreases the strength of the current in the induction bobbins between them, and this current in its turn increases or decreases the strength of the field magnets of the main line generators, and cause a rise or fall in the pressure or electro-motive force of the line currents, according as more or less energy is drawn from the stations by putting on or taking off lamps or electric engines.

Thus I am enabled to cause a rise or fall in the pressure or electro-motive force by turning of the commutator handle. To indicate the rise and fall of electro-motive force the operator at the commutator has before him the electro dynometer, as well as several standard lamps, to indicate the rise and fall.

This apparatus I propose to place in a separate room from the main rooms containing the generators and engines, the connection therewith being made by wires, but the movements of the commutator are transferred by gearing and shafts to large dials, one in the generator room and one in the engine room, so that the station master may know the proper time to start up or stop down one or more of the engines. It may sometimes happen in practice that from the breaking of belts or a wire or other causes that a generator will cease to supply electricity to the main lines, even when the induction bobbin is intact; this will cause the currents from the other generators to pass through this generator, and perhaps burn the wire. To prevent this I interpolate a short wire in the induction bobbin circuit, made of bismuth or other fusible metal, which will melt and break the circuit, and save the wires of the generator before too great a heat is reached.

Between each generator I place a loose pulley supported by a gudgeon, to which pulley the belt may be shifted in case a generator is to be repaired when the system of generators of which it is one is in use.

It is well known that at different parts of the main circuit outside of the generators electric engines almost similar to the generators may be placed for the purpose of giving out power to the shafting.

I find that several electro-magnetic engines giving varying amounts of power, from 20 horse to $\frac{1}{10}$ of a horse, may be worked in multiple arc. The less the power required the smaller the engine, and the greater the power required the finer the wire used, and I find that it is preferable to place the greatest length of the wire and resistance upon the field magnet.

In using these electro magnetic engines in multiple arc for running a sewing machine or other small machine I arrange a switch for disconnecting the machine from the circuit, a belt to connect the motor with the sewing machine, using a

very small pulley on the motor and a large pulley on the sewing machine so as to allow of high speeds in the motor. I regulate the speed of sewing by a friction lever pressing on the driving pulley of the sewing machine, which lever being connected to the foot rest may be pressed lightly or heavily on the pulley of the sewing machine, and thus increase or diminish its speed instantly or stop it altogether. The pulley of the motor being a friction pulley allows the motor shaft to revolve at a slower speed even when the belt is stopped.

When the motor is arranged to pump water to a tank I use a float which, when the water becomes too low, closes a circuit and connects the motor to the main line, and when the water is sufficiently high the float serves to disconnect the motor from the electric circuit.

For running machine shops with these motors, and where an even speed is required, I arrange upon the shaft of the motor a governor working in the ordinary manner, but which when the speed has reached a certain point causes a lever to open the circuit and disconnect the motor from the circuit.

These motors can be worked upon the same main conductors as the lamps.

Edison's Impts. in Apparatus for Developing Electric Currents for Electric Lights.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 1st July 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME IN CIRCUITS THAT PASS TO ELECTRIC LIGHTS OR ELECTRO MAGNETIC ENGINES."

In my system of electric lighting I have proposed in a previous Patent to regulate the pressure or electromotive force at the central station by varying the strength of the field magnets around the induction bobbins connected to the main conductors, any rise or fall in the electro motive force due to putting on or off lamps being indicated by an electrometer. I find that an electro dynamometer similar to that of Weber, but of high resistance, is an improvement upon the electrometer owing to its greater reliability. Two of such are used and connected across the main conductors in multiple arc. In my system a city is to be divided up into districts; in each district there is a central station, which station is provided with sufficient motive power and electric generators to supply half a mile radius. At this station I employ, say, five engines, each of two hundred and fifty horse power. Each engine runs by a belt a separate line of shafting; on this shafting is belted, say, forty electric generators, so that each engine and its system of generators may be considered complete within itself. Two large rods of copper are in proximity to all the generators, and connecting levers are arranged so that any generator may be placed across and feed into the two main conductors. All the generators when connected to the mains are connected in multiple arc, and the field magnet of every generator is so wound, or the pulleys upon its shaft so made, that by increase or decrease of speed, or by a weakening or strengthening of the field magnet, the electro motive force of the induction may be adjusted to exactly the same electromotive force in all the machines. I employ several subsidiary electric generators belted on the shaft of the first engine which are all in use, and the currents from these machines are conveyed by leading wires to the field magnet of all the generators and serve to keep a constant field. A second series of these subsidiary machines is connected to the shaft of the second engine, and connected in duplicate so as to be used in case of emergency or in case the first engine stops.

A switch is provided for changing one subsidiary generator from one set to another set, so that the change can be made gradually. The subsidiary generators are also arranged in multiple arc, but the field magnets of main line generators are so connected that there will be a row of, say, 10 magnets connected in series, and these sets connected in multiple arc. Switches are provided whereby, say, ten field magnets are disconnected at once, the induction bobbin having previously been disconnected from the mains. For energizing the field magnets of the subsidiary generators I use a dynamo electric machine, the current from which passes through the field magnets of all the subsidiary generators either in series or in multiple arc. In this circuit I place a large number of resistance coils of large wire and subdivided, so that each has, say, one fiftieth of an ohm. resistance.

A wire between each resistance coil leads to a rotary commutator, which by being turned short circuits a greater or less number of resistance coils, thus increasing or decreasing the strength of the current in the field magnets of the subsidiary generators, this in its turn increases or decreases the strength of the current in the induction bobbins between them, and this current in its turn increases or decreases the strength of the field magnets of the main line generators, and causes a rise or fall in the pressure or electromotive force of the line currents, according as more or less energy is drawn from the stations by putting on or taking off lamps or electric engines. Thus I am enabled to cause a rise or fall in the pressure or electromotive force by turning of the commutator handle. To indicate the rise and fall of electromotive force the operator at the commutator has before him the electro dynamometer, as well as several standard lamps, to indicate

Edison's Impts. in Apparatus for Developing Electric Currents for Electric Lights.

the rise and fall. This apparatus I propose to place in a separate room from the main rooms containing the generators and engines, the connection therewith being made by wires, but the movements of the commutator are transferred by gearing and shafts to large dials, one in the generator room and one in the engine room, so that the station master may know the proper time to start up or stop down one or more of the engines. It may sometimes happen in practice that from the breaking of belts, or a wire, or other causes, that a generator will cease to supply electricity to the main lines, even when the induction bobbin is intact; this will cause the currents from the other generators to pass through this generator and perhaps burn the wire. To prevent this I interpolate a short wire in the induction bobbin circuit made of bismuth or other fusible metal, which will melt and break the circuit, and save the wires of the generator before too great a heat is reached. Between each generator I place a loose pulley supported by a gudgeon, to which pulley the belt may be shifted in case a generator is to be repaired when the system of generators of which it is one is in use. It is well known that at different parts of the main circuit outside of the generators, electric engines almost similar to the generators may be placed for the purpose of giving out power to shafting. I find that several electro magnetic engines giving varying amounts of power, from twenty horse to $^1/_{20}$ of a horse, may be worked in multiple arc. The less the power required the smaller the engine, and the greater the power the finer the wire used, and I find that it is preferable to place the greatest length of the wire and resistance upon the field magnet.

In using these electro magnetic engines in multiple arc for running a sewing machine or other small machine, I arrange a switch for disconnecting the machine from the circuit, a belt to connect the motor with the sewing machine, using a very small pulley on the motor and a large pulley on the sewing machine, so as to allow of high speeds in the motor. I regulate the speed of sewing by a friction lever pressing on the driving pulley of the sewing machine, which lever being connected to the foot rest may be pressed lightly or heavily on the pulley of the sewing machine, and thus increase or diminish its speed instantly or stop it altogether; the pulley of the motor being a friction pulley allows the motor shaft to revolve at a slower speed even when the belt is stopped.

When this motor is arranged to pump water to a tank I use a float, which, when the water becomes too low, closes a circuit and connects the motor to the main line, and when the water is sufficiently high the float serves to disconnect the motor from the electric circuit. For running machine shops with these motors, and where an even speed is required, I arrange upon the shaft of the motor a governor working in the ordinary manner, but which when the speed has reached a certain point, causes a lever to open the circuit and disconnect the motor from the circuit. These motors can be worked upon the same main conductors as the lamps.

Having now described the nature of my said Invention and in what manner the same is or may be performed, I declare that I claim as my Invention,—

The method herein specified of regulating and controling the action of magneto electric generators and governing the electro motive force throughout a system of conductors, in which system are included electric lamps or magneto electric motors, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Fifteenth day of June, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 140, Nassau St., New York.
GEO. T. PINCKNEY, " "

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A.D. 1880, 10*th* *February*. N° 578.

Electric Lamps.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for an Invention of "IMPROVEMENT IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 10th February 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

For an electric lamp I prefer to use an incandescing conductor of high resistance hermetically sealed in a glass chamber.

Great difficulty has always been experienced in so sealing a glass vacuum globe or chamber that a complete union of parts was had, and danger of opening or separation avoided. In all vacuum sealing of which I am cognizant there has never been a complete union of the parts where the parts joined were attempted to be joined in vacuo. There might be a union forming a tight joint lasting some indefinite time under ordinary conditions, yet critical examination would always reveal a line showing incomplete juncture, where, under the influence of heat or conditions present in an electric lamp, an opening would occur. One part of my Invention therefore relates to a method of manufacturing electric lamps so that a stable vacuum may be maintained therein.

In manufacturing my lamps a glass bulb is formed with a long but small tube extending therefrom, by which the bulb is to be attached to the air pumps, and it is preferably curved so that several may be attached to one pump.

Upon the opposite side from the tube is formed a supporting neck of a size sufficient to permit the introduction through it into the body of the bulb of the carbon arc.

A piece of small tubing is formed with a round head at one end, smaller than the neck referred to, for receiving the supporting and conducting wires of the arc. The tube, a little below this bend, is enlarged to the size of the neck.

Upon the head a part of the glass where the platinum wires pass is formed of white enamel glass having a greater conducticity for heat than the main part of the vessel. The enamel glass through which the platinum wires pass is then melted and

[*Price* 8*d*.]

sealed around them by fusion, the glass extending some little distance above the general plane of the head around the glass, or *vice versa*. On the outside of the bulb the platinum wires are joined to copper or aluminium wires which pass out through the lower or open end of the tube. Clamps for holding the incandescent conductor are secured to the upper ends of the platinum wires, and the incandescent conductor secured therein. The head is then passed into the neck until the lower edge of the neck and the enlargement of the tube below the head meet, when the two are there joined together by fusion.

The lamp is now ready for exhaustion, and for this purpose it is attached by the tube referred to to an air pump. When the proper degree of vacuum has been reached the tube is closed by fusion at the point of juncture with the pump, and the lamp removed from the pump. The tube is then sealed by fusion at or near the plane of the bulb. There is now the same degree of vacuum upon each side of this last seal that is in the bulb and in the tube between the two seals made.

The vacuum in the tube is now destroyed, and the tube again sealed just above the seal at or near the plane of the bulb; the vacuum in the bulb is now protected by two sealings, the one in vacuo and one in air. I find that this double sealing makes a complete and perfect union of the parts, so that a stable vacuum may be maintained.

In manufacturing these lamps I use within the vacuum chamber only such materials as when subjected to influences within the chamber consequent upon the light do not injuriously effect the light. For instance, iron or steel under the influence of heat vaporize to a slight extent, and platinum in its ordinary state always contains some air or gas. I therefore use platinum or metals of that group prepared and treated by a process hitherto announced by me, or aluminium may be used for the supporting clamps and for the metallic parts within the vacuum chamber.

If a definite area of radiating surface be raised to a definite temperature a definite amount of light is the result, a definite electro motive force, or as I have termed it, "pressure" of current is required, and the conductors or mains are proportioned to all these conditions.

I have discovered that if the resistance of the light giving medium be increased, its radiating surface remaining the same, the same amount of light will be produced, but the conductors may be diminished in size proportionally to the increase of resistance, much less proportionate increase of pressure of current however being required.

For example, let all the lamps in circuit have incandescent conductors of 100 ohms resistance each, and 1000 pounds of copper conductor be used in the main conductors, and 100 volts, be required to keep the lights up. If now the radiating surface of each lamp be unchanged, but the resistance of each be raised to 200 ohms., 500 pounds of copper conductor will answer for main conductors, and 140 volts. will be required to keep the lights up to the same point, hence by doubling the resistance of the lamp one half of the prime cost of the conductors will be saved, the amount of energy expended remaining the same, about 3000 foot pounds being required to maintain the light in either case, which is entirely independent of the resistance.

Another part of my Invention therefore relates to utilizing this discovery by so adjusting the radiating surface resistance and pressure relatively to each other that great economy in conductors may result. In one form I increase the resistance, the resistance in the light, by taking a filament of carbon long enough to give twice the ordinary resistance, and double it upon itself, keeping the two surfaces electrically apart. In this case the contiguous sides radiate little if any light, each obscuring the other, but I obtain the increased resistance necessary to enable me to use small conductors.

A number of arcs may be connected together as a series in one lamp, in which event an increase of resistance (equal to number used) and of radiating surface

would be secured with a proportionate decrease in the amount of conductor necessary.

As a necessary part of any practical system of electric lighting for domestic uses it appears to be essential that an electric lamp should be simple in construction and complete within itself, requiring no skill in placing in position or in manipulation.

To provide for this upon the lower end of the lamp, as described under the first head, an insulating ring is secured, upon the opposite sides of which are placed two contact springs, one of the conductors leading from the incandescent conductor being secured to each.

A holder is made by hollowing out a piece of insulating material shaped or ornamented, as desired, the bottom being fashioned so as to be secured in any suitable support, say, a bracket or chandelier arm. On the interior of the hollow (which is of a size to receive the neck of the lamp) are two metallic pieces insulated from each other; to one is fastened a conductor leading directly or indirectly from the source of electricity, opposite the other piece, and upon the exterior of the holder is a metallic nut, to which the other main conductor leads. A screw passes through this nut, and may be made to impinge against the interior plate so as to electrically connect the nut and plate. The main conductors may pass to the holder through ordinary gas or other tubing, and through the bracket or chandelier arms, or in any other suitable way.

From this description it is evident that a lamp holder may be so made that the lamp may be placed in position in or removed from the holder without any skill or manipulation of binding posts or fastening devices, and that the current for lighting is turned off or on by simply turning the screw connecting one plate and the nut.

It is evident that the portion of the neck of the lamp entering the socket may be round or square, or many sided, or provided with a feather, lugs, or splines, the holder being correspondingly hollowed out.

It is also evident that the neck and holder may be made of such relative size that the neck shall slide upon and over instead of within the holder.

In a prior application, filed by me on the 10th November 1879, I have stated how fibrous material capable of carbonization may be coiled in a spiral in order that a large resistance may be had with comparatively small radiating surface. In an application, filed by me on the 15th December 1879, I have shown how an incandescent conductor of small radiating surface with large resistance may be made of paper properly carbonized.

I have since discovered that an incandescent conductor of very high resistance in comparison to the radiating surface may be made of such natural vegetable fibres as are capable of carbonization. I prefer to use the fibre of bleached manilla hemp, although any vegetable fibres which are large, round, and filamentary, instead of cellular may be used. In using these fibres I wind the ends with tissue paper and then carbonize them, the tissue paper wrapping forming an enlarged end, which gives a good bearing for the supporting clamps.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 10th August 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN ELECTRIC LAMPS, AND IN THE METHOD OF MANUFACTURING THE SAME."

For an electric lamp I prefer to use an incandescent conductor of high resistance hermetically sealed in a glass chamber.

Great difficulty has always been experienced in so sealing a glass vacuum globe or chamber that a complete union of the parts was had, and danger of opening or separation avoided.

In all vacuum sealing of which I am cognizant there has never been a complete union of the parts where the parts were attempted to be joined in vacuo. There might be a union forming a tight joint lasting an indefinite time under ordinary conditions, yet critical examination always revealed a line shewing incomplete juncture, when under the influence of heat or conditions present in an electric lamp an opening would occur.

One part of my invention therefore relates to a method of manufacturing lamps so that a stable vacuum may be maintained therein. In manufacturing my lamps a glass bulb is formed with a long small tube extending therefrom by which the bulb is to be attached to the air pump, and it is preferably curved so that several may be attached to one pump. Upon the opposite side from the tube is formed a supporting neck of a size sufficient to permit the introduction through it into the body of the bulb of the carbon arc. A piece of tubing is formed into a round head at one end, smaller than the neck referred to, for receiving the supporting and conducting wires of the arc. The tube a little below this head is made as large as the neck. A part of the head where the platinum wires pass may be formed of white enamel glass having a greater conductivity for heat than the main part of the vessel, or it may be of plain glass. The glass through which the platinum wires pass is melted and sealed around them by fusion, the glass extending some little distance above the general surface of the head around the wires, or *vice versa*, on the outside of the bulb.

The platinum wires are joined to copper or alluminium wires which pass out through the lower or open end of the tube.

Clamps for holding the incandescent conductor are secured to the upper ends of the platinum wires, and the incandescent conductors secured therein. The head is then passed into the neck until the lower edge of the neck and the enlargement of the tube below the head meet, and the two are there joined together by fusion. The lamp is now ready for exhaustion, and for this purpose it is attached by the tube aforesaid to an air pump. After the proper degree of vacuum has been reached the tube is closed by fusion at the point of juncture with the pump, and the lamp removed from the pump. The tube is then sealed by fusion at or near the plane of the bulb; there is now the same degree of vacuum upon each side of the last seal. The vacuum in the tube is now destroyed, and the tube again sealed just above the seal at or near the plane of the bulb. The vacuum in the bulb is now protected by two sealings, one in vacuo and one in air. I find that this double sealing makes a complete and perfect union of the parts, so that a stable vacuum may be maintained.

In manufacturing these lamps I use within the vacuum chamber only such material as when subjected to influences within the chamber consequent upon the light do not affect the light. For instance, iron or steel under the influence of heat in a vacuum vaporize to a slight extent and form carburet of iron, while

platinum in its ordinary state always contains some air. I therefore use platinum or metals of that group prepared and treated by heat in vacuum, as heretofore announced by me, or else aluminium for the supporting clamps and for all metallic parts within the vacuum chamber.

If a definite area of radiating surface be raised to a definite temperature a definite amount of light is the result, a definite electro motive force of electricity, or, as I have termed it, "pressure" of current being required therefor, the conductors or mains being proportioned to all these conditions.

I have discovered that if the resistance of the light giving body be increased, its radiating surface remaining the same, the same amount of light will be produced, but the conductors may be diminished in size proportionally to the increase of resistance, much less proportionate increase of pressure of current however being required. For example, if all the lamps in circuit have incandescent conductors of one hundred ohms resistance, each then one thousand pounds of copper conductor should be used in the main conductors, and one hundred volts will be required to maintain the lights. If now the radiating surface of each lamp be unchanged, but the resistance of each be raised to two hundred ohms, five hundred pounds of copper conductor will answer for main conductors, one hundred and forty volts, however being required to keep the lights up to the same point, so that by doubling the resistance the prime cost of one half the conductors is saved, the amount of energy expended remaining the same, about three thousand foot pounds being required to maintain the light in either case, which is entirely independent of the resistance.

Another part of my Invention therefore relates to utilizing this discovery by so adjusting the radiating surfaces, resistances, and pressure relatively to each other that great economy in conductors may be obtained. In one form I increase the resistance by taking a filament of carbon long enough to give twice the ordinary resistance, and double it upon itself, keeping the two surfaces electrically apart. In this case the contiguous sides radiate but little light, as each obscures the other, but I obtain the increased resistance necessary to enable me to use the smaller conductors.

A number of arcs may be connected together as a series in one lamp, in which event there is an increase of resistance equal to the number used, and radiating surfaces are secured with a proportionate decrease in the amount of conductor necessary. As a necessary part of any practical system of electric lighting for domestic uses it is essential that the electric lamp should be simple in construction, and complete within itself, requiring no skill in placing in position or in manipulating it.

To provide for this an insulating ring is secured upon the lower end of the neck of the lamp, and upon the opposite side of this ring are placed two contact springs, one of the conductors leading from the incandescent conductor being secured to each. A cup shaped holder is made of insulating material, ornamented as desired, the bottom being fashioned so as to be secured in any suitable support, such as a bracket or chandelier. On the interior of the cup, which is of a size to receive the neck of the lamp, are two metallic plates opposite to but insulated from each other. To one is fastened a conductor leading directly or indirectly from the source of electricity, and upon the exterior of the holder is a metallic nut, to which the other main conductor lands. A screw passes through this nut, and may be made to impinge against the other metallic piece, so as to electrically connect the nut and plate. The main conductors may pass to the holder through ordinary gas or other tubing, and through the bracket or chandelier arm, or in any other suitable way.

From this description it is evident that a lamp holder may be so made that the lamp may be placed in position in or removed from the holder without any skill or manipulation of binding posts or fastening devices, and that the current for lighting is turned off or on by simply turning the screw that presses upon one of the plates. It is evident that the portion of the neck of the lamp entering the

socket may be round, or square, or many sided, and provided with a feather, lugs, or spliner, the holder being correspondingly hollowed out. It is also evident that the neck and holder may be made of such relative size that the neck shall slide upon and over instead of within the holder. In a prior application for Letters Patent I have stated how fibrous material capable of carbonization may be coiled in a spiral in order that a large resistance may be had with comparatively small radiating surface. I have also shown how an incandescent conductor of small radiating surface with large resistance may be made of paper properly carbonized. I have since discovered that an incandescent conductor of very high resistance in comparison to the radiating surface may be made of such natural fibers as are capable of carbonization. I prefer to use the single fiber of bleached manilla hemp, although any of the fibers which are large, round, and filamentary instead of cellular may be used, as hereafter set forth. In using these fibers I wind the ends with tissue paper and then carbonize them, the tissue paper wrapping forming an enlarged end, which gives a good bearing for the supporting clamps.

Figs. 1, 2, 3, 4, & 5 illustrate the method of manufacturing my improved lamp, showing the steps therein successively.

A piece of tubing the size of *c* is taken, on which is blown or otherwise formed the bulb *b*, whose upper portion is drawn out into the tube *h* curved so that several bulbs may be attached to one air exhausting pump. The part *c* is left unchanged in order to form a supporting neck for the lamp; in forming this from tubing however the lower end is often drawn out as shown in Fig. 1; this small end is removed on the line *x*, *x*, leaving the globe neck and tube as shown in Fig. 2; *f* is a piece of glass tubing of a size somewhat less than *c*; upon its upper end is formed the bulb *d* and the two seals *p*, *p*, for the wires. Below *d* the enlargement *e* is formed in the tube *f*, its exterior diameter being the same or nearly so as that of *c*. Platinum wires *w*, *w*, joined to conductors 1, 2, are passed through openings in the projections *p*, *p*, which projections are then fused by heat around the wires *w*, *w*, so as to seal the wires hermetically in the glass, said seals extending around the wires above the general surface of the bulb *d*. Clamps h^1, h^1, are attached to the wires, and the incandescent conductor fastened in the clamps. It is to be here remarked that the clamps or wires within the globe must be of some material not so affected by any influences existing within the globe when the proper vacuum has been attained as to interfere with the light or its proper dissemination. If iron be used it is so acted on that it is gradually destroyed with an ensuing deposit on the glass obscuring the transparency of the globe, and also acting on the carbon, uniting with it, and finally destroying it. In order to prevent this, and to guard against any injurious influences whatever, the clamps h^1, h^1, and wires within the globe should be of platinum or some metal or metals of the platinum group, treated by the vacuum and heating process described by me in a prior application for a Letters Patent. The arc *a* and bulb *d* are inserted in the neck *c* until the end *x*, *x* of the neck *c* rests against the enlargement *e*, when the two are securely and hermetically joined by fusion of the glass at that point. The tube *e* is large enough to allow the carbon arc, which is slightly flexible, to pass through it. The lamp is attached by the tube *h* to an exhaust pump of any suitable character, and after the proper degree of exhaustion has been reached the tube *h* is sealed by fusion of the glass at *i* and removed from the pump, and a second seal *l* is made in the tube *h* immediately above the globe *b*. This last sealing is made entirely in vacuo, and the degree of vacuum in *b* and in *h* between *l* and *i* is the same. I have found however that a perfect and durable seal cannot be made when all the portions of the glass which unite to form the seal are in a vacuum when the seal is made, hence the seal *i* at the end of the tube *h*. The tube *h* is now sealed by fusion at *m*, or it may be broken off at *m* and a drop of molten glass placed therein, and the parts melted to form the seal. The seal l^1, Fig. 5, is therefore the result of two sealings, at *l* in vacuo, and at *m* in air.

I have found that such a seal is lasting under all conditions, and that by the method here indicated a globe is so constructed and sealed that a vacuum perfectly

stable is maintained therein. The wires 1 & 2 for attachment to devices for completing the circuit pass out of the end of the tube *f*, and in order to prevent their accidental crossing or displacement a plug *n* of cork, plaster of Paris, or other insulating material is put in the end of *f* securing the wires therein.

Figs. 6, 7, 8, 9, 10, and 11 show modifications in which the resistance of the incandescent arc is increased. In Fig. 6 *b* is the enclosing globe. Several incandescent conductors *a*, each of the standard resistance, are united at their ends in a series by conducting clamps *h*, the terminal ends of the series connecting to clamps h^1, h^1, to which are attached the wires *w*, *w*. The series are supported upon *d* in circular form by wires or other supports 3, 3. In this case the current entering by 1 traverses one carbon and passes by clamp *h* to the next, and so on through the series to conductor 2. Five of these carbons are shown in Figs. 6 and 7. As each incandescent portion *a* is of standard resistance, and gives a standard light, the object of this arrangement is to group a number of such lights, and to light a much larger area than one light would, at the same time the total resistance of the lamp being proportionately increased the size of the conductors or street mains is proportionately lessened, there being consequently great economy in the laying thereof, and the number of street lamps required being lessened it is practicable to light thinly settled highways and streets.

In Figs. 9, 10, and 11, a strip *a* of carbonized material is employed of standard resistance for a given length, but of twice the ordinary length, and the same is doubled upon itself. At the point of bending back an insulating block *o* is introduced, so that the folded carbonized strip is kept apart. To the free ends are attached the clamps h^1, h^1, and conductors *w*, *w*. Each inner contiguous surface is partially hidden by the other, so that the outer surface is the portion that radiates light, and this is to be equal to the total surface of an ordinary or undoubled carbon; but the increase of length has doubled the resistance, hence there is a double resistance with little change in the radiating surface. This double resistance however enables a smaller conductor to be used, the amount of metal in this instance being diminished one half. This ability to diminish the amount of metal in conductors is of great importance, as in many instances, notably in thinly settled localities, it may determine the practicability of a system of electric lighting. It also enables localities far distant from a central station or source of electric energy to be supplied with electric energy for purposes of light and power when under ordinary conditions, or under conditions which have usually existed, the first cost of conductors and the cost of maintenance would prove insurmountable obstacles.

An incandescent conductor of very high resistance in proportion to its radiating surface may be made of any natural fiber capable of carbonization, especially such as are large and filamentary instead of cellular. A preferable one for this purpose is a single fiber of bleached manilla hemp. A fiber is taken, its ends wound with tissue paper and then carbonized, the carbonization uniting the fiber and paper wrapping, the latter forming an enlarged end, which gives a good bearing for the supporting clamps. Figs. 12 and 13 show my lamp manufactured as hereinbefore described with additions and modifications, rendering it a separate and complete article adapted for attachment to a suitable support. Upon the lower end of the part *c* is secured a cylinder *q* of any suitable insulating material, provided on opposite sides with metallic springs or contact pieces 13, 14. From the clamps h^1, h^1, which hold and support the incandescent arc *a*, the conductors 1, 2, lead to the contact pieces 13, 14, adapted to complete the electrical circuit when the lamp is placed in position in the holder hereafter described.

This construction forms a separate electric lamp, which may readily be removed from or placed upon or within a suitable holder, the act of placing the lamp in position completing without adjustment or attention the necessary connection of the circuit to the light giving portions. *r* is a socket or holder for receiving the the lamp. It is made of suitable insulating material, shaped and ornamented as may be desired, receiving and supporting the neck of the electric lamp, and

fashioned at one end so as to be fastened onto a gas fixture or other suitable support, as shown. The cylindrical cup or socket for the lamp is at the top, and a screw threaded aperture in the base allows the holder to be attached to a standard, a bracket, or a chandelier arm *t*. Upon the interior are the metallic plates *u*, *v*, insulated from each other. Upon the exterior of the holder is a metallic nut *s* in which works the metallic screw *y*. A conductor 5 leads to the plate *u*, and a conductor 6 to the nut *s*; upon turning the screw *y* electric connection between the plate *v* and nut *s* is either completed or broken dependent upon the direction of turning. The conductors 5, 6, lead directly or indirectly from the source of electricity, and may be placed inside of gas or other suitable pipes or tubing, as shown in Fig. 12, or they may be brought to the lamp in any convenient manner. From this it may be seen that if the lamp be placed in the socket *r*, as shown in Fig. 12, one spring 13 bears against and forms electrical contact with one plate, say *u*, while the other spring 14 bears against and forms electrical contact with the other plate *v*.

If the screw *y* be turned so as to impinge firmly on plate *v* a complete circuit is formed *via* wire 5, plate *u*, spring 13, wire 2, incandescent arc *a*, wire 1, spring 14, plate *v*, screw *y*, nut *s*, and wire 6, the maximum light, a dim light, or no light, being due respectively to a fine contact, a slight contact, or no contact between *v* and *y*.

From the description it is evident that the lamp is an article complete in itself, capable of being placed in position for use without any attention or adjustment. While I have shown contact springs upon the cylinder *q* or the neck of the lamp, and contact plates upon the interior of the socket or holder, it is evident that the relation could be reversed, the plates being placed on the neck of the lamps, and the springs in the socket without departing from the spirit of my Invention, or requiring any further Invention. It is also evident that the lamp can be so constructed that the neck will embrace the holder instead of being placed therein.

What I claim as my Invention is,—

First. The method of forming electric lamps, consisting in separately forming the enclosing globe and the supporting bulb for the incandescent conductor, attaching the wires and incandescent conductor thereto, and then hermetically uniting the parts prior to the formation of the vacuum, substantially as set forth.

Second. The method of hermetically sealing a vitrified vacuum chamber, which consists of first sealing in vacuo and then sealing in the air, substantially as described.

Third. The clamps and wires made of platinum or metals of the platinum group or conductors of electricity not affected by influences within the lamp, substantially as described.

Fourth. In a system of generation, distribution, and translation of electricity for purposes of light, the method of diminishing the amount of metal required in a given length of main conductors by increasing the resistance of the lamps, substantially as described.

Fifth. An incandescent conductor formed of several separate conductors joined together, substantially as set forth.

Sixth. An incandescent conductor formed of a long strip doubled upon itself, so as to increase the resistance and maintain a given radiating surface, substantially as set forth.

Seventh. An incandescent conductor formed of a single carbonized fiber, substantially as described.

Eighth. An incandescent conductor having a body formed of a single fiber with enlarged ends made of paper wrapped upon the ends of the fiber and carbonized, substantially as set forth.

Ninth. A separate electric lamp adapted to be readily removed from, or placed, or replaced upon or within a suitable holder, substantially as herein described.

Tenth. The combination of a separate removable electric lamp and a suitable holder, substantially as herein described.

Eleventh. The combination of a separate removable lamp, a suitable holder, and electric conductors, which complete the circuit when desired to said lamp, but are not attached thereto, substantially as herein described.

Twelfth. An electric lamp consisting of a glass globe, substantially of one piece of glass, hermetically sealed, and enclosing in a vacuum material capable of being rendered incandescent by an electric current, and provided at its base with contact pieces, substantially as herein described.

Thirteenth. The combination in an electric lamp of a glass globe enclosing in a vacuum material capable of being rendered incandescent by an electric current, an insulated base, spring contacts, and conductors therefrom to the incandescent material, substantially as herein described.

Fourteenth. A socket or holder for electric lamps consisting of an insulating cylinder formed to receive and support the lamp, and provided with two contact plates and a circuit controling device for controling the circuit to one of the contact plates, substantially as herein set forth.

Fifteenth. The combination with a bracket or chandelier arm of a socket or holder adapted to receive and support an electric lamp, substantially as herein set forth.

Sixteenth. The combination of a holder, bracket, or chandelier arm with a socket or holder adapted to be received thereon, and to receive and support an electric lamp and conductors passing through the arm to contact plates in the holder, substantially as herein set forth.

Seventeenth. The combination with a socket or holder provided with suitable contact plates of a lamp provided with corresponding contact springs upon its exterior, substantially as herein set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 29 day of June, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
S. L. GRIFFIN,
FRANK McLAUGHLIN.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
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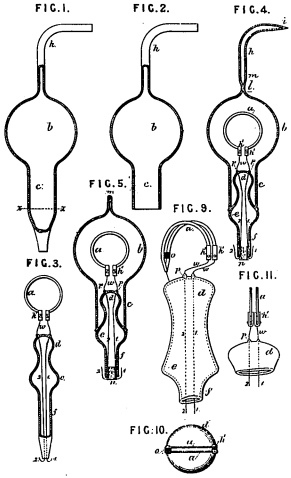
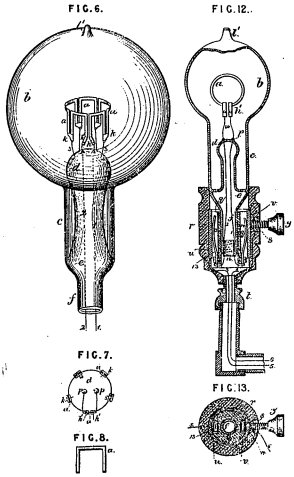
1880.





Malby & Sons, Photo-Lith.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1880.

A.D. 1880, 11th *February*. N° 599.

Anæsthetic Compound.

LETTERS PATENT to William Robert Lake, of the Firm of Haseltine, Lake, & Co., Patent Agents, Southampton Buildings, London, for an Invention of "AN IMPROVED ANÆSTHETIC COMPOUND." A communication from abroad by Thomas Alva Edison, of Menlo Park, New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said William Robert Lake at the Office of the Commissioners of Patents on the 11th February 1880.

WILLIAM ROBERT LAKE, of the Firm of Haseltine, Lake, & Co., Patent Agents, Southampton Buildings, London. "AN IMPROVED ANÆSTHETIC COMPOUND." [A communication from abroad by Thomas Alva Edison, of Menlo Park, New Jersey, United States of America.]

The object of this Invention is to provide means for producing anæsthetic effects upon the nerves by external application for obtaining relief from pain until nature or medicines may effect a cure.

The said Invention consists, first, in providing a compound comprising a number of the most powerful chemical substances which act anæsthetically and which have no effect upon each other.

It further consists in combining with such compound various menstruums for dissolving the said substances, which menstruums shall have no chemical action upon each other or upon the said substances other than to effect their solution.

The object of placing in one compound all of the most powerful chemical compounds which act anæsthetically is to ensure that if one does not act the others may, as it is well known that a certain anæsthetic may in one case produce the effect, but in another case will not produce anæsthesia, while an inferior anæsthetic will produce an anæsthesia.

In addition it is believed from the surprising effects of this preparation when compounded according to the formula given below, that in some way the action of one anæsthetic quickens the action of the others.

The ingredients which I use in practising this Invention are hydrate of chloral, chloroform, ether, nitrate of amyl, morphia, opium, camphor, alcohol, oil of

[*Price 4d.*]

peppermint, salicylic acid, and oil of cloves. The alcohol, ether, and chloroform act anæsthetically as well as being menstruums for dissolving the other ingredients.

The preferable proportions are as follows, that is to say:—

1 oz. of hydrate of chloral, 4 ozs. of alcohol, 2 ozs. of chloroform, 2 ozs. of camphor, 2 minims of oil of peppermint, 2 minims of oil of cloves, 3 pennyweights of salicylic acid, 3 pennyweights of nitrate amyl, 2 pennyweights of morphia sulphate, 2 ozs. of ether.

But the proportions may be varied, and more of one substance and less of the others may be used; the amount of the different substances should be such that the menstruums will dissolve them. Other anæsthetics may be added to this combination, or one or more of those mentioned may be dispensed with, but to meet all of the various conditions of the human nerves it is better for the compound to contain all of the most powerful anæsthetics, to the end that should one, two, or three, or more fail to act while applied separately, there must be one or more among the whole which will produce relief, especially when they are commingled and applied together.

This preparation is designed for external application only.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said William Robert Lake in the Great Seal Patent Office on the 10th August 1880.

WILLIAM ROBERT LAKE, of the Firm of Haseltine, Lake, & Co., Patent Agents, Southampton Buildings, London. "AN IMPROVED ANÆSTHETIC COMPOUND." A communication from abroad by Thomas Alva Edison, of Menlo Park, New Jersey, United States of America.

The object of this Invention is to produce anæsthetic effects upon the nerves by external application to obtain relief from pain until nature or medicine may effect a cure.

The said Invention consists, first, in a compound of a number of the most powerful chemical substances which act anæsthetically and which have no effect upon each other.

If further consists in placing in such compound various menstruums for dissolving the said substances, which menstruums shall have no chemical action upon each other or upon the said substances other than to effect their solution.

The object of placing in one compound all of the most powerful chemical compounds which act anæsthetically, is to ensure the action of one of them, that is to say, if one does not act the others may, as it is well known that a certain anæsthetic may in one case produce the desired effect, but in another case will not produce anæsthesia, while an inferior anæsthetic will produce anæsthesia.

Furthermore, it is believed from the surprising effects of this preparation when compounded according to the formula given below, that in some manner the action of one anæsthetic quickens the action of the others.

The ingredients which I use are hydrate of chloral, chloroform, ether, nitrate of amyl, morphia, camphor, alcohol, oil of peppermint, salicylic acid, and oil of cloves. The alcohol, ether, and chloroform act anæsthetically, and also as menstruums for dissolving the other ingredients.

The proportions I prefer to use are as follow, that is to say:—One ounce of hydrate of chloral, four ounces of alcohol, two ounces of chloroform, two ounces of camphor, two minims of oil of peppermint, two minims of oil of cloves, three pennyweights of salicylic acid, three pennyweights of nitrate amyl, two pennyweights of morphia sulphate, two ounces of ether.

But these proportions may be varied, and more of one substance and less of the others may be used; the amount of the different substances should be such that the menstruums will dissolve them. Other anæsthetics may be added to this combination, or one or more of those mentioned may be dispensed with, but to meet all of the various conditions of the human nerves it is better that the compound should contain all of the most powerful anæsthetics, to the end that should one, two, three, or more fail to act while applied separately, there must be one or more among the whole which will produce relief, especially when they are commingled and applied together.

I prefer menstruums which are also anæsthetics, but other menstruums will serve the purpose of this Invention provided they do not combine chemically with the other ingredients used.

This preparation is designed for external application only.

Lake's Improved Anæsthetic Compound.

Having thus fully described the said Invention as communicated to me by my foreign correspondent and the manner of performing the same, I wish it understood that I claim,—

The medicinal preparation compounded substantially as above described.

In witness whereof, I, the said William Robert Lake, have hereunto set my hand and seal, this Twenty ninth day of July, in the year of our Lord One thousand eight hundred and eighty.

WM. ROBT. LAKE. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.

A.D. 1880, 11th *February*. N° 602.

Utilization of Electricity for Light, Heat, and Power.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for an Invention of "IMPROVEMENTS IN THE UTILIZATION OF ELECTRICITY FOR LIGHT, HEAT, AND POWER, BEING AN IMPROVED SYSTEM AND MEANS FOR THE GENERATION, REGULATION, DISTRIBUTION, MEASUREMENT, AND TRANSLATION OF ELECTRICITY INTO LIGHT, HEAT, OR POWER."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 11th February 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN THE UTILIZATION OF ELECTRICITY FOR LIGHT, HEAT, AND POWER, BEING AN IMPROVED SYSTEM AND MEANS FOR THE GENERATION, REGULATION, DISTRIBUTION, MEASUREMENT, AND TRANSLATION OF ELECTRICITY INTO LIGHT, HEAT, OR POWER."

The object of this Invention is to so arrange a system for the generation, supply, and consumption for either light, heat, or power, or either or all, of electricity that all the operations connected therewith requiring especial care, attention, or knowledge of the art shall be performed for many consumers at stations, leaving the consumer only the work of turning off or on the supply, as may be desired; in other words to so contrive means and methods that electricity may be supplied for consumption in a manner analogous to the system for the supply of gas and water, without requiring any greater care or technical knowledge on the part of the consumer than does the use of gas or water, in order that economy, reliability, and safety may be insured.

In carrying the Invention into effect a city, town, village, or locality may form one district, or if the extent of territory makes it desirable may be divided into several districts.

In each district I provide a central station, at which are grouped a suitable prime motor or several motors, dependent upon the amount to be supplied, generators or means for converting the prime motive power into electricity, means for determining and regulating the amount of electricity generated and supplied, in order that a constant pressure of electricity (so to speak) may be kept up.

The prime motors are any suitable engines, steam or water, and one or a series of two or more are provided as may be necessary, each of which is provided with

[*Price* 8*d*.]

its own system of shafting and belting driving a number of magneto electric machines, the number actuated by one prime motor being hereinafter termed a battery.

It is to be noted, as is also shown in previous applications for Patents made by me, that I make my field of force magnets exceedingly long, and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating coil. By this extra length, as the magnetic tension at the poles increases with their distance apart, there is secured at the polar extensions acting upon the coils in the field of force a much greater magnetic intensity, or so to speak, a greater motive force or pressure, causing consequently the generation of a greater amount of energy in the coils operated on than would result from the use of shorter magnets, even though the same mass of metal were used therein. By this elongation of the cores I am enabled to dispense with numerous convolutions or layers, one layer of wire being sufficient, whereby the resistance of the machine is largely diminished. The large mass of metal in these magnets is magnetically saturated by a weak current passing around them. It takes this weak current a long time to bring this mass of metal up to the point of practical maximum magnetic intensity, but once brought to that point the weak current readily keeps them there, while with a shorter magnet a stronger current would more speedily magnetically saturate them; this stronger current would still be required to keep them so saturated.

If the coils of the field of force magnets and the generating coils were included in one circuit, and all the currents generated were passed through the field magnet coils, a very much greater amount of current than necessary for the maintenance of a practical magnetic maximum in the field of force magnets would be passed around them, and the coils acting as resistances to the energy in excess of that required to magnetise the magnet to its practical maximum would cause a great waste of electric energy; hence I prefer to keep the field of force magnets and the generating coils separate, and that one machine in each battery (which machine may be termed the battery field of force generator) be used to supply the requisite energy to the field of force magnets of the other machines in such battery (which may be termed the supply generators).

The coils of the field of force magnets are connected as a series in a multiple arc in one circuit, while the generating coils of the supply generators of each battery are all connected in a multiple arc to the main conductors (though for special purposes they may be connected as a series).

This will give great economy, as the per cent. of the entire current generated in each battery absorbed in keeping up the magnetic maximum in the field of force magnets, when it is furnished by one special machine of the battery, the number given it to feed being properly calculated, being less than when a portion of the current generated in each machine is absorbed in its own field of force magnets.

Where a single battery of machines is used it is preferable, in view of what has been hereinbefore stated, that the current for the coils of the field of force magnets of the field of force generators of the battery be supplied by a small galvanic battery, but if more than one battery of machines be used the field of force generators of all the batteries are fed from one or more prime field of force generators connected in a multiple arc or in a series, the field of force magnets of the prime field of force generator or generators used being kept magnetically saturated by a weak galvanic battery current, as before set forth. For instance, a weak galvanic current supplies the field current necessary for one prime field of force generator, which in turn feeds the field of force magnets of the field of force generators of ten batteries of twenty or thirty machines, the ultimate effect in the generation of currents depending upon (as one important factor) the tension of the galvanic current sent through the field of force coils of the prime field of force generators.

This prime field of force generator may however be a dynamo electric machine

instead of a magneto machine, its field of force being kept up by the current generated in the machine instead of by a galvanic current.

At the central station all the supply generating coils or batteries thereof are connected to conductors on the multiple arc system, and from these conductors at the station main conductors (which for convenience may be called simply the mains), connected thereto on the multiple arc system, lead in any and all desired directions, conveying the energy to the points where work either by translation into light or motive power is to be done.

In order to give a better understanding of the method of regulating what for convenience may be called the pressure of the current through the entire system, I will here state that all the devices for the transmission of electricity into work are arranged on the multiple arc system, each device being in its own derived circuit, the effect being in substance to give each a circuit from the generating source independent of the circuit of all the other devices; as a resultant it follows that the greater the number of transmitting devices brought into circuit, the less the total resistance of the current.

For instance, I prefer my lamps should be of about 100 ohms resistance, then if one lamp only be in circuit there is a resistance of 100 ohms; if another lamp be put in circuit, two circuits of 100 ohms are provided for the current, making the net total resistance to the current 50 ohms.

Although the resistance in each derived circuit remain unchanged, this effect is ordinarily opposite to the effect produced by the addition of lamps when they are connected in an ordinary straight circuit, each one then adding to the resistance of the circuit. The bringing into operation successively of numbers of the devices, and thereby making more paths or circuits for the currents, does not appreciably lessen the pressure or diminish the effect upon the devices in use, the active force at the central station, viz., prime field of force generators and motive power, remaining unchanged until the net resistance of the devices in circuit exterior to the battery of machines is so diminished as to approach in a degree the resistance of the battery and main conductors, it being remembered that as the machines of a battery are connected in multiple arc the net internal resistance of a battery is as many times less than one as there are machines in the battery.

To avoid any appreciable variations and insure uniformity it is essential that any lessening of pressure be immediately indicated, in order that just sufficient energy be generated and sent out to keep up an equal flow through the circuit of each translating device, that is, that the pressure be kept up uniform whether more or less translating devices be in circuit.

This is obtained by providing at the central stations means for constantly indicating the pressure and for regulating the production of appreciable variation to be indicated at each station test lights are arranged, so that an approximate visual test of the effect of pressure upon the circuit of any translating devices in use may be shown.

From what has been said it is evident that as more or less translating devices are brought into circuit the total resistance of the circuit, or all the circuits thereof, to the flow of all the current generated varies. To indicate this electrodynamometers, galvanometers, or electrometers are placed across the main conductors at the central station, or by return wire at any point in the circuit, with a zero mark placed to correspond with the deflection consequent upon the maintenance of the proper amount of pressure.

It may be advisable (and I have so done) to place at the central station a series of standard "Daniell's" batteries, connected by a switch circuit to the galvanometer or dynamometer, in order that they may be frequently tested for any inaccuracy occurring from any cause whatever. By these means any error whatever therein is readily detected.

To correct variations in the pressure various means may be employed. Each supply generator may be connected into the circuit through a switch, and each series may be likewise so connected, so that the current of one or more of a series,

or one or more entire series, may be cut out or thrown into the circuit; or each machine may be arranged so as to be disconnected from the prime motor, or when needed the prime motor of an entire series may be disconnected.

The plan I prefer however is to arrange in connection with the circuit of the battery feeding the field of force magnets of the prime field of force generator before referred to, a series of resistances so that the energy of the battery current may be varied, this variation causing in turn a variation in current induced in prime field of force generator, and in all the generators directly or indirectly controlled thereby. When a dynamo machine is used these resistances are to be used in same manner in connection with the circuit including the coils around the field magnets.

For distributing the current thus generated and regulated at the central station, I prefer to use conductors within insulated pipes or tubing made water tight and buried in the earth, provision being made at suitable intervals for house or side connections.

While this plan is preferable for many reasons it is evident that conductors may be carried in the air or over house tops. While only one pair of conductors may be laid on each street, I prefer, especially where streets are wide, to lay a pair of conductors along each side of the street near the curb. At proper intervals street lamps may be connected thereto by derived circuits.

From main conductors on principal streets subsidiary main conductors are laid through side streets; from the street conductors, wherever desired, derived circuits are led into the houses, one of the conductors passing through a suitable meter, preferably one which measures the amount of electricity passing through, as set forth in my Patent, No. 4226, of October 23, 1878.

In the house each translating device is placed in a derived circuit, the entire system of means for generation, conduction, and translation being one great multiple arc system. The translating device in each house may be either for light or power, or both. For light, the electric lamp consisting of an incandescing material hermetically sealed in glass is preferred.

This lamp is made of high resistance in comparison with that of any electric lamps which to my knowledge have been proposed. In lights heretofore proposed the endeavour seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, 10 ohms, but I have discovered a very much higher resistance, say, 100 ohms, must be used in order that a number may be economically and successfully used in a system.

The motor used should be so constructed that each with a constant flow or pressure of current will give the exact power required.

This requires that each motor should be wound with finer or coarser wire, and with more or less convolutions which determine the maximum effect of the motor. In addition, as the motors may be run with variable loads or amount of work to perform, and as irregularity of speed would be a consequent thereof, it is preferable to provide each motor with a governor, which on excessive speed would operate to break the circuit of the motor or otherwise control it. A preferable form of governor, therefore, will form the subject matter of an application for Patent to be filed by me.

A system arranged as thus described provides for all the conditions precedent to an economical and reliable utilization of electricity as a lighting or motive power agent.

As within certain ascertainable limits the greater the horse power of an engine the less the proportionate cost per horse power, by consolidating at one station the prime motive force necessary to the generation of a supply for many consumers, a great economy as to production occurs.

As ordinarily proposed, each electric light requires its own regulator, which usually is either thermostatic or magnetic, breaking the circuit or bringing in resistances, in any case making a cumbrous lamp requiring delicate management and constant attention.

By regulating at the central station entirely I am enabled to use a small separate

lamp, which may be used with the exercise of no more than ordinary care or attention.

The distribution is so provided for that tampering therewith is guarded against, and that connections from the mains to localities of translation are readily made. The means for measuring insures accurateness, and in furnishing a basis for equitable charges for the amount used by one particular consumer.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 11th August 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN THE UTILIZATION OF ELECTRICITY FOR LIGHT, HEAT, AND POWER, BEING AN IMPROVED SYSTEM AND MEANS FOR THE GENERATION, REGULATION, DISTRIBUTION, MEASUREMENT, AND TRANSLATION OF ELECTRICITY INTO LIGHT, HEAT, OR POWER."

The object of this Invention is to so arrange a system for the generation, supply, and consumption for either light or power, or both, of electricity that all the operations connected therewith requiring special care, attention, or knowledge of the art shall be performed for many consumers at central stations, leaving the consumer only the work of turning off or on the supply, as may be desired; in other words, to so contrive means and methods that electricity may be supplied for consumption in a manner analogous to the system for the supply of gas and water, without requiring any greater care or technical knowledge on the part of the consumer than does the use of gas or water, in order that economy, reliability, and safety may be ensured.

In carrying the Invention into effect a city, town, village, or locality may form one district, or if the extent of territory makes it desirable may be divided into several districts. In each district I provide a central station, at which are grouped a suitable prime motor or several motors, dependent upon the amount to be supplied, generators or means for converting the prime motive force into electricity, means for determining the amount of electricity generated and supplied, in order that a constant pressure of electricity (so to speak) may be kept up. The prime motors are any suitable engines, steam or water, and one or a series of two or more are provided as may be necessary, each of which is provided with its own system of shafting and belting driving a number of magneto electric machines, the number actuated by one prime motor being hereinafter termed a battery. It is to be noted that I make my field of force magnets exceedingly long and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating coil. By this extra length, as the magnetic tension at the poles increases with their distance apart, there is secured at the polar extensions acting upon the coils in the revolving armature a much greater magnetic intensity, or so

to speak a greater magneto motive force or pressure, causing consequently the generation of a greater amount of energy in the coils operated on than would result from the use of shorter magnets, even though the same mass of metal were used therein. By this elongation of the cores I am enabled to dispense with a number of layers of coils, as one layer of wire is usually sufficient, whereby the resistance of the machine is largely diminished. The large mass of these magnet cores is magnetically saturated by a weak current passing around them. It takes this weak current a long time to bring this mass of metal up to the point of practical maximum magnetic intensity, but once brought to that point the weak current readily keeps them there, while with a shorter magnet a stronger current would more speedily magnetically saturate them; this stronger current would still be required to keep them so saturated.

If the coils of the field of force magnets and the generating coils were included in one circuit, and all the current generated was passed through the coils of the field magnet, a very much greater amount of current than necessary for the maintenance of a practical magnetic maximum in the field of force magnets would be passed around them, and the coils acting as resistances to the energy in excess of that required to magnetize the magnet to its practical maximum would cause a great waste of electric energy; hence I prefer to keep the coils of the field of force magnets and the generating coils separate, and that one machine in each battery (which machine may be termed the battery field of force generator) be used to supply the requisite energy to the field of force magnets of the other machines in such battery (which may be termed the supply generator).

The coils of the field of force magnets are connected as a series or in multiple are in one circuit, while the generating coils of the supply generators of each battery are each and all connected in a multiple arc to the main conductors (though for special purposes they may be connected as a series).

This arrangement ensures great economy, as the per cent. of the entire current generated in each battery absorbed in keeping up the magnetic maximum in the field of force magnets when it is furnished by one special machine of the battery, the number given it to feed being properly calculated, being less than when a portion of the current generated in each machine is absorbed in its own field of force magnets.

Where a single battery of machines is used it is preferable, in view of what has been herein before stated, for the current to the coils of the field of force magnets of the battery generators be supplied by a small galvanic battery, but if more than one battery of machines be used the field of force generators of all the batteries are fed from one or more prime field of force generators connected in a multiple arc or in a series, the field of force magnets of the prime field of force generator or generators used being kept magnetically saturated by a weak galvanic battery current, as before set forth. For instance, a weak galvanic current supplies the field current necessary for one prime field of force generator, which in turn feeds the field of force magnets of the field of force generators of ten batteries of twenty or thirty machines, the ultimate effect in the generation of current depending upon (as one important factor) the tension of the galvanic current sent through the field of force coils of the prime field of force generators. The prime field of force generators may however be a dynamo electric machine instead of a magneto machine, its field of force being kept up by the current generated in the machine instead of by a galvanic current.

At the central stations all the supply generating coils or batteries thereof are connected to conductors on the multiple arc system, and from these conductors as the station main conductors (which for convenience may simply be called the mains), connected thereto also on the multiple arc system, lead in any and all desired directions for conveying the energy to the points where work either by translation into light or motive power is to be done. In order to give a better understanding of the method of regulating what for convenience may be called the pressure of the current through the entire system, I will here state that all the

devices for translation of electricity are arranged on the multiple arc system, each device being in its own derived circuit, the effect being in substance to give each a circuit from the generating source independent of the circuit of all the other devices. As a resultant it follows that the greater the number of translating devices brought into circuit the less the total resistance of the circuit. For instance, I prefer that my lamps shall each be of about one hundred ohms resistance, then if one lamp only be in circuit there is a resistance of one hundred ohms; if another lamp be put in circuit two circuits each of one hundred ohms are provided for the current, making the net total resistance to the current fifty ohms. Although the resistance in each derived circuit remains unchanged, this effect is the opposite of the effect produced by the addition of lamps when they are connected in an ordinary straight circuit, each one then adding to the resistance of the circuit.

The bringing into operation successively of numbers of the devices, and thereby making more paths or circuits for the current, does not appreciably lessen the pressure or diminish the effect upon the devices in use, the active force at the central station, *viz.*, prime field of force generators and motive power, remaining unchanged until the net resistance of the devices in circuit exterior to the battery of machines is so diminished as to approach in a degree the resistance of the battery and main conductors, it being remembered that as the machines of a battery are connected in multiple arc the net internal resistance of a battery is as many times less than one machine as there are machines in the battery.

To avoid any appreciable variation and ensure uniformity it is essential that any lessening of the pressure be immediately indicated, in order that just sufficient energy be generated and sent out to keep up an equal flow through the circuit of each transmitting device; that is, that the pressure be kept up uniform whether more or less translating devices be in circuit.

This is attained by providing at the central station means for constantly indicating the pressure and for regulating the production. If appreciable variation be indicated at such station test lights are arranged, so that an approximate visual test of the effect of pressure upon the circuit of any translating devices in use may be shown. From what has been said it is evident that as more or less translating devices are brought into circuit the total resistance of the circuit, or all the circuits thereof, to the flow of all the current generated varies.

To indicate this electro-dynamometers, galvanometers, or electrometers are placed across the main conductor at the central station, or by return wire at any point in the circuit, with a zero mark placed to correspond with the deflection consequent upon the maintenance of the proper amount of pressure. It may be advisable (and I have so done) to place at the central station a series of standard Daniel batteries, connected by a switch circuit to the galvanometer or dynamo galvanometer, in order that they may be frequently tested for any inaccuracy occurring from any cause whatever. By these means any error is readily detected. To correct variations in the pressure various means may be employed. Each supply generator may be connected into the circuit through a switch, and each series may be likewise so connected, so that the current of one or more of a series, or one or more entire series, may be cut out or thrown into the circuit; or each machine may be arranged so as to be disconnected from the prime motor; or, when needed, the prime motor of an entire series may be disconnected.

The plan I prefer however is to arrange in connection with the circuit of the battery feeding the field of force magnets of the prime field of force generator before referred to, a series of resistances so that the energy of the battery current may be varied, this variation causing in turn a variation in current induced in the prime field of force generator, and in all the generators directly or indirectly controlled thereby; where a dynamo machine is used these resistances are to be used in the same manner in connection with the circuit including the coils around the field magnets. For distributing the current thus generated and regulated at the central station, I prefer to use conductors within insulated pipes or tubing made water tight and buried beneath the earth, provision being made at

suitable intervals for house and side connections. While this plan is preferable for many reasons it is evident that a conductor may be carried in the air or over house tops.

While only one pair of conductors may be laid on each street, I prefer, especially where streets are wide, to lay a pair of conductors along each side of the street near the curb. At proper intervals street lamps may be connected thereto by derived circuits. From the main conductors on principal streets, subsidiary main conductors are laid through side streets. From the street conductors, wherever desired, derived circuits are led into houses, one of the conductors passing through a suitable meter, preferably one which measures the amount of electricity passing through. In the house each translating device is placed in a derived circuit, the entire system of means for generation, conduction, and translation being one great multiple arc system. The translating device in each house may be either for light or power, or both. For light, the electric lamp consisting of an incandescent material hermetically sealed in glass is preferred. This lamp should be of a high resistance in comparison with the resistance of any electric lamp which to my knowledge has hitherto been proposed. The endeavour seems to have been to lessen the resistance of the carbon, but I have discovered that a very high resistance, say, one hundred ohms, must be used in order that a number may be economically and successfully used in a system.

The motor used should be so constructed that each with a constant flow or pressure of current will give the exact power required. This requires that each motor should be wound with finer or coarser wire, and with more or less convolutions which determine the maximum effect of the motor.

In addition, as the motor may be run with variable loads or amounts of work to perform, and as irregularity of speed would be a consequent thereof, it is preferable to provide each motor with a governor which, on excessive speed, will operate to break the circuit of the motor or to otherwise control it.

A system arranged as thus described provides for all the conditions precedent to an economical and reliable utilization of electricity as a lighting or motive power agent.

Within certain ascertainable limits the greater the horse power of an engine the less the proportional cost per horse power; so in my system by consolidating at one station the prime motive force necessary to the generation of a supply for many consumers a great economy is attained.

As ordinarily proposed, each electric light requires its own regulation, which usually is either thermostatic or magnetic, breaking the circuit or bringing in resistances, in any case making a cumbrous lamp, requiring delicate management and frequent attention. By regulating at the central station entirely I am enabled to use a small separate lamp which may be managed with the exercise of no more than ordinary care or attention. The distribution is so provided for that tampering therewith is guarded against, and that connections from the mains to the translating devices are readily made. The means for measuring ensure accuracy, and furnish a basis for equitable charges for the amount used by any particular consumer.

In the Drawings accompanying and forming part of this Specification an arrangement of means is shown for carrying my Invention into effect, although it is to be particularly noted that the Invention is not dependent upon the specific means and their arrangement described and shown, but that they may be varied without departing from the spirit of my Invention. In these Drawings Fig. 1 is a plan of a central station.

Fig. 2 is a modification of Fig. 1.

„ 3 is a plan illustrating the street mains and house connections, with translating devices properly introduced.

„ 4 is a plan showing a locality divided into four districts. In Fig. 1 three batteries of generators c, c^1, c^2, are shown, which may be increased or diminished as circumstances may demand. One generator c of each battery is used to generate the current feeding the field of force magnets of the machines in its battery, the

circuit from such field generator through the field of force coils in each battery being shown by the dotted lines 2, 2, 2.

For actuating the rotary parts an engine D is used with each battery connecting by belt d to line of shafting E, from which belts e pass to each generator. The coils of each magneto battery in which currents are generated are connected, as in c^1 and c^2, in multiple arc to conductors 3, 3, 3, 3, which in turn are connected in multiple arc to main conductors 6, 6, from which lead in multiple arc the street conductors or mains 7, 7, or, as is shown in part of battery c, each machine may be directly connected in multiple arc to the station conductor 6, 6. F is the prime field of force generator supplying the battery field of force generators c, c, c, its circuit being shown in dotted lines 1, 1. The field of force magnets of F are magnetized by a current from the galvanic battery G, in whose circuit is arranged the series of resistances H provided with the cut out K, by which more or less of the resistances are put in or out of the circuit feeding the field magnets of F. This arrangement forms a very effective and simple method of regulating the production of electric current or the pressure at the central station, for the current generated by F being dependent upon the intensity of the magnetization of its field of force magnets which in turn depends upon the current transmitted around the magnets by the battery G. As the resistance varies such current, it follows that by varying the resistance in the circuit of G the current generated by F varies, which in turn varies the current generated in c, c, c, which in turn varies the current generated in the supply machines of the batteries, proportionate increase of current and rise of pressure in the latter following increase of current around the magnets of F, and *vice versa*. One or more test lamps T L are placed at the central station in derived circuits to serve as a photometric test of the pressure in the line. For more accurately indicating variations in the pressure one or more electrometers, galvanometers, or electro dynamometers E D are placed in derived circuits with scale marks indicating the deflection caused by the electric pressure so as to compare the same with the standard pressure to be maintained. By the proper use of these indicating devices and the regulating devices described, a uniform pressure may be readily and easily maintained through all the mains. It is preferable to connect all circuits from the generating machines to the main conductors 6, 6, through switches I, I, I, so that an entire battery or any portion thereof may be thrown in or out of circuit as the demand upon the station may indicate. It is to be noted also that the belt to the pulley of each machine is to be so arranged by any well known plans that it may be disconnected from the motor when desired, and in this manner the number of machines in operation may be controlled, and the effective force of each machine while in operation is regulated by the resistance in the circuit G. The engine may be of any desired pattern or power, the number of machines in any one battery being limited by the power of the engine.

In Fig. 2 c, c, c, c, are the generators for the field of force magnets in batteries not shown, and c^1 is the field of force generator of a battery of which three supply generators c^1, c^2, c^3, are shown connected to station conductors 6, 6, as before explained.

The prime field of force generator F^1 is in this case a dynamo-electric machine instead of a magneto electric machine, as shown in Fig. 1, all its coils being included in one circuit 8, 8, which passes around the field of force magnets of the battery generators c, c, c, c, c^1. The same principle of regulation is used however, the resistance H and cut out K therefore being arranged in connection with the circuit through F^1 so as to cause variation in the tension of the current therein, as and with the result before explained. In this Figure there is shown what may be used also in connection with the plan shown in Fig. 1, *viz.*, means of testing the electro-dynamometer E D or other indicating instrument used. From a standard Daniel's Battery, D B a circuit $t\,c$ may be formed through E D by means of the switch L when moved to the position shown by dotted lines, so that the correctness of E D may be ascertained periodically, and any inaccuracies which might arise be guarded

against; usually the switch L remains as shown in full lines, and ED is in a branch between the main conductors 6, 6.

The main conductors 7, 7, Fig. 3, are to be connected with the corresponding wires at central stations (see Fig. 1), and lead down each side of the street M S. The conductors 7, 7, also branch off into intersecting streets I S. The small circles *o* in this Figure indicate electric lamps. For street lighting they are placed as shown in derived circuits from the street mains. From the mains derived circuits 9, 9, lead into houses, in which are placed at suitable spots the meters M, through which one of the house conductors passes, and by which the amount of electricity supplied to the house is accurately determined. Upon these house circuits are arranged lamps *o*, on the multiple arc system, in such number, position, and grouping, as may be desired. In these circuits I also propose to introduce electro-motors E M, wherever desired for furnishing light motive power. From the motor a belt *i* leads to a line of shafting *h* and pulleys *a*, *a*, for any needed distribution of the power, or the belt *i* may pass directly to a sewing or other machine, a separate motor being used for each power driven machine.

Where motors are desired each preferably should be made of a power proportionate to the maximum work to be done. While the electrical tension in each machine is regulated at the central station, yet if the maximum load or work be diminished at any particular motor its speed would necessarily be increased; it also might be desired at times to diminish the normal speed of the motor. In order, therefore, that some determinate speed may be maintained irrespective of load or work, each motor should be furnished with a governor to regulate the electric circuit and the speed.

In Fig. 4 is shown a locality divided into four supply districts; each is provided with its own central station marked CS^1, CS^2, CS^3, and CS^4. From each station the mains 7, 7, lead out, as before described. At convenient points, however, say P P, connections between the mains of the stations may be made, as shown in dotted lines, the effect then being to merge the entire locality into one large district with four supply stations, the pressure through all being uniform, and each station doing its own quota toward maintaining the uniform pressure. The use of four stations and districts in this diagram is arbitrary, and for illustration only, as the number actually employed in any one locality depends upon the area of the district and the number of lights to be maintained.

What I claim as my Invention is,—

First. A system for the generation and application of electricity consisting in the combination of means at a central station for generating the electricity and for indicating and regulating its pressure, means for distributing the electricity, and devices for translating it into light or motive power, substantially as set forth.

Second. A system for the generation and application of electricity consisting in a combination of means at a central station for generating the electricity, and for indicating and regulating its pressure, means for distribution, means for translating, and means for measuring the amount used by each consumer, substantially as set forth.

Third. The method of regulating the electro motive force or pressure in the main conductors by regulating the strength of the field of force magnets of the main magneto electric machines, so that variation of pressure upon the connection or disconnection of translating devices may be prevented, substantially as set forth.

Fourth. The method of regulating the amount of effect at the translating devices by regulating the field of force current of the generators, substantially as set forth.

Fifth. The method of regulating the generative capacity of one or a battery of magneto electric or dynamo electric machines by regulating the current passing through the field of force magnets, substantially as set forth.

Sixth. The method of regulating the generative capacity of one or a battery of

magneto electric or dynamo electric machines by varying the resistance of the circuit passing around the field of force magnets, substantially as set forth.

Seventh. The method of operating a battery of magneto electric machines by using the entire current of one machine of the battery to supply the field of force current of the remainder, and throwing the entire current of the latter into a circuit for use, substantially as set forth.

Eighth. The combination with one electrical circuit of a number of separate translating devices, substantially as set forth.

Ninth. The combination with one main electrical circuit of a number of separate translating devices arranged therein upon the multiple arc system, substantially as set forth.

Tenth. The combination with a number of translating devices of one regulator placed at a central station and regulating all the said devices, substantially as set forth.

Eleventh. The combination with one or a battery of generators and a number of translating devices of means for constantly indicating the electric pressure upon the translating devices, substantially as set forth.

Twelfth. The combination of a number of generators and a number of translating devices, all arranged upon derived circuits or multiple arcs, substantially as described.

Thirteenth. The combination with means for constantly indicating the electric pressure of a battery for testing the indicating means, substantially as described.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this 29 day of June, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
S. L. Griffin.
Frank McLaughlin.

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1880.

A.D.1880. Feb. 11. No 602.
EDISON'S Specification.

SHEET 1.

FIG. 1.

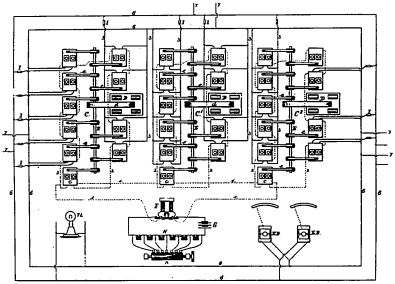
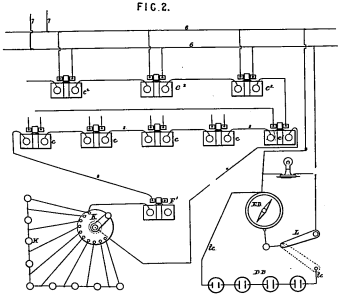


FIG. 2.



Malby & Sons, Photo-Litho.

Lithgow, Printed by [illegible] Edward Eyre and William Spottiswoode
Printers [illegible] Street, Excellent Majesty 1880.

FIG.3.

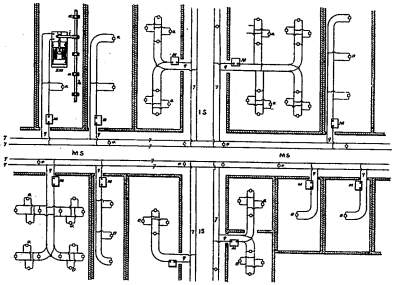
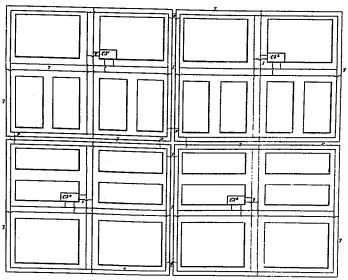


FIG.4.



Malby & Sons, Photo-Litho.

London, Pr[illegible] Edward Eyre and William Spottiswoode.
[illegible] Edison Printers Malmesbury 1880.

A.D. 1880, *5th April.* N° 1385.

Electric Machines and Motors.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for an Invention of "IMPROVEMENTS IN DYNAMO OR MAGNETO ELECTRIC MACHINES AND ELECTRIC MOTORS."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 5th April 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN DYNAMO OR MAGNETO ELECTRIC MACHINES AND ELECTRIC MOTORS.'

A portion of my Invention relates to the rotating armatures, the arrangement of the commutator brushes or contacts, and the shaft of the rotating armature and commutator, which are applicable to both dynamo or magneto electric machines and to electric motors.

In rotating armatures made of a solid mass of metal, or of several large rings of metal, currents are induced in the armature itself, which circulate from points of greatest to those of lowest potential.

To such currents is largely due the heating of the armature so often present as an injurious element in such armatures.

To remedy this I construct an armature of a number of very thin discs or rings secured together upon a proper shaft or base, and slightly insulated from each other. I have found that very good results are attained by using discs or rings, one thirty second to one sixty fourth of an inch thick, separated from each other by sheets of tissue paper. As currents induced in the rotating armature have very small electro motive force, the insulation of the tissue paper and the thinness of the plates prevent almost, if not quite, entirely the circulation of induced currents and the heating attendant thereon. By this the effective capacity of the machine for conversion is very largely increased, for while the heating at one moment is not large the covering of the armature prevents radiation, and the accumulation of heat proceeds faster than its dissipation, and the armature becomes an accumulating receiver of heat until the capacity of the machine for conversion is much impaired by limitation of exterior energy due to this heating, all of which is obviated by this use of exceedingly thin plates or discs. In this connection, as the word thin is a relative one, it is well to state that the plates should be at most not more than an eight of

[*Price 6d.*]

an inch thick, and preferably very much thinner and insulated from each other in order to attain these effects.

Commutator springs or brushes have always been arranged at right angles to the axis of the commutator.

With such there has usually been a large amount of "spark" on the face of the commutator indicating a loss of electric energy by its conversion at a point where conversion was not only unneeded, but injurious, causing a rapid destruction of the commutator apparatus. I find that this can be largely and usually entirely avoided by arranging the commutator springs or brushes so that their axial line is at an angle other than a right angle with the axis of the commutators, or in other words, that the brushes or springs bear obliquely upon the face of the commutator.

In practice I have found that it is better that the brushes or springs stand at an angle of about 30° to the axis of the commutator.

As ordinarily arranged the brushes or springs travel over the face of the commutator in a uniform track speedily wearing a groove therein, rendering the face of the commutator uneven.

To remedy this, insuring even wear over the whole surface of the commutator, and also to insure even wear and polishing of the surface of the revolving armature, I arrange the shaft of the commutator and its bearings so that the shaft may have a longitudinal movement in the bearings. Upon the outer end of the shaft a disc is fixed forming a circular armature to an electro magnet suitably attached to the frame of the machine. When this magnet is charged, attracting the armature, the shaft is moved in one direction to its limit of motion, a spring serving to force it to the other limit when the magnet is inactive.

If an iron pulley be used upon the shaft of the armature and commutator and placed near the polar extension of the field magnets the spring may be dispensed with, the magnet for moving the shaft being placed to move the shaft in one direction, the attraction between the machine magnets and the pulley serving to move the shaft in the other direction. Attached to any rotating part of the apparatus is a disc, a portion of whose periphery is of insulating material, the remainder being a conductor, or the disc may have several alternating conducting and non-conducting portions. Upon the disc bears a contact spring, the disc and spring being interposed in a circuit leading from a battery or other source of electricity to the magnet last spoken of, or the current therefor through a shunt may be a portion of the machine itself, one rotating disc and spring may be arranged to control the circuit of the shaft moving magnets of a large number of machines or motors.

In providing electro motors for any given work it is desirable that any one motor should be constructed to give the maximum power required with a certain definite current.

As is the case with all motors, however, it may be desired to use the motor for less than its maximum capacity, that is to run it with a variable load or amount of work to be performed, it is preferable that it should be provided with a governor to correct any fluctuations in speed consequent upon such variation in load or work.

To accomplish this I place on the main shaft, or I gear to it either directly or by belting, a centrifugal governor which lifts upon too great speed, an adjustable circuit lever controlling by either making or breaking directly or indirectly the circuit to the motor; this lever may control directly the circuit to the motor passing through it, or it may control indirectly by controlling a local battery circuit to a magnet, whose armature lever operates a circuit breaker placed in the motor circuit. In order to prevent too sudden fluctuations upon the breakage of circuit, and to maintain regularity while the current is on, the main shaft is provided with a heavy fly or balance wheel, whose momentum prevents irregularities and causes gradual slowing down when the circuit is broken. As the circuit controlling lever of the governor completes the circuit through an adjustable stop, the joint effects of the governor and fly wheel are that the machine is capable of

the finest adjustment, breaking and completing the circuit upon the least variation from a determined desired speed acting exactly, so to speak, as an automatic cut off in steam engines, preventing unnecessary consumption of energy.

The breaking of the main circuit occasions a large spark at the breaking point, which is more destructive as a unit than it would be if divided into several sparks, hence I break the main circuit when breakage is necessary at several points simultaneously, in order to divide the spark and lessen its total injurious effect. I accomplish this by fixing upon an insulating base several contact springs, the free ends of which rest each respectively upon proper contact posts, and project slightly beyond the same. The circuit is led to one post, passes to its spring whence it passes by a wire to the next post into its spring by wire to next post, and so on through the series of springs and posts. Either the circuit controlling lever or the armature lever, as either is used for the purpose as before explained, is broadened at the end, so as to take under the extreme free ends of all the circuit springs, and upon desired movement lift them from their posts, breaking the main circuits at a number of points.

In using electric motors, especially for actuating light machinery, it is very desirable that the rate of speed of the actuated machine be under control of the operator, and that the means of control be simple, effectual, and easy of application.

Hitherto this has been attempted only through controlling the electric circuit to the motor, breaking or closing it in whole or in part.

I propose to control the speed by the application of a brake to the main driven wheel without reference to the current. A brake is so pivoted as to be capable of bearing upon the wheel, but kept therefrom normally by a spring.

Attached to the brake is a lever which in turn is attached to a treadle, by means of which any desired pressure may be applied, though it is evident that the brake lever may be arranged to be operated by hand instead of through the medium of a treadle.

So far as I am aware electric motors have always been connected direct to the actuated machine, so that the rate of speed of the actuated machine and of the motor were the same. It is often desirable that the actuated machine be driven at a less or at a greater rate of speed than the motor. To effect this I interpose between the two differential gearing, that is, gearing which may be cogged wheels, pinion wheels, friction gearing, belts and pulleys, or equivalents of different diameter, arranging them to produce the desired differential speed.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 5th October 1880.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN DYNAMO OR MAGNETO-ELECTRIC MACHINES AND ELECTRIC MOTORS."

A portion of my Invention relates to the rotating armature, the arrangement of the commutator brushes or contacts and the shaft of the rotating armature and commutator, which are applicable to both dynamo or magneto electric machines and to electric motors.

In rotating armatures made of a solid mass of metal, or of several large rings of metal, currents are induced in the armature itself which circulate from points of greatest to those of lowest potential.

To such currents is largely due the heating of the armature so often present as an injurious element in such armatures.

To remedy this I construct an armature of a number of very thin disks or rings secured together upon a proper shaft or base, and slightly insulated from each other. I have found that very good results are attained by using disks or rings one thirty second to one sixty fourth of an inch thick, separated from each other by sheets of tissue paper. As currents induced in the rotating armature have very small electro-motive force, the insulation of the tissue paper and the thinness of the plates prevent almost, if not quite, entirely the circulation of induced currents and the heating attendant thereon. By this the effective capacity of the machine for conversion is very largely increased, for while the heating at one moment is not large, the covering of the armature prevents radiation, and the accumulation of heat proceeds faster than its dissipation, and the armature becomes an accumulating receiver of heat until the capacity of the machine for conversion is much impaired by limitation of exterior energy due to this heating, all of which is obviated by this use of exceedingly thin plates or disks. In this connection, as the word "thin" is a relative one, it is well to state that the plates should be at most not more than an eighth of an inch thick, and preferably very much thinner and insulated from each other in order to attain these effects.

Commutator springs or brushes have always been arranged at right angles to the axis of the commutator. With such there has usually been a large amount of "spark" on the face of the commutator, indicating a loss of electric energy by its conversion at a point where conversion was not only unneeded but injurious, causing a rapid destruction of the commutator apparatus.

I find that this can be largely, and usually entirely, avoided by arranging the commutator springs or brushes so that their axial line is at an angle other than a right angle with the axis of the commutators, or in other words, that the brushes or springs bear obliquely upon the face of the commutator.

In practice I have found that it is better that the brushes or springs stand at an angle of about 30° to the axis of the commutator. As ordinarily arranged the brushes or springs travel over the face of the commutator in an uniform track, speedily wearing a groove therein, rendering the face of the commutator uneven.

To remedy this, ensuring even wear over the whole surface of the commutator, and also to ensure even wear and polishing of the surface of the revolving armature, I arrange the shaft of the commutator and its bearings so that the shaft may have a longitudinal movement in the bearings. Upon the outer end of the shaft a disk is fixed, forming a circular armature to an electro magnet suitably attached to the frame of the machine. When this magnet is charged, attracting the armature, the shaft is moved in one direction to its limit of motion, a spring serving to force it to the other limit when the magnet is inactive.

If an iron pulley be used upon the shaft of the armature and commutator, and placed near the polar extension of the field magnets, the spring may be dispensed with, the magnet for moving the shaft being placed to move the shaft in one direction, the attraction between the machine magnets and the pulley serving to move the shaft in the other direction. Attached to any rotating part of the apparatus is a disk, a portion of whose periphery is of insulating material, the remainder being a conductor; or the disk may have several alternating conducting and non-conducting portions. Upon the disk bears a contact spring, the disk and spring being interposed in a circuit leading from a battery or other source of electricity to the magnet last spoken of, or the current therefor through a shunt may be a portion of the machine itself. One rotating disk and spring may be arranged to control the circuit of the shaft moving magnets of a large number of machines or motors.

In providing electro motors for any given work it is desirable that any one motor should be constructed to give the maximum power required with a certain definite current. As is the case with all motors, however, it may be desired to use the motor for less than its maximum capacity, that is, to run it with a variable load or amount of work to be performed; it is preferable that it should be provided with a governor to correct any fluctuations in speed consequent upon such variation in load or work. To accomplish this I place on the main shaft, or I gear to it, either directly or by belting, a centrifugal governor which lifts upon too great speed, an adjustable circuit lever, controling by either making or breaking, directly or indirectly, the circuit to the motor. This lever may control directly the circuit to the motor passing through it, or it may control indirectly, by controling a local battery circuit to a magnet whose armature lever operates a circuit breaker placed in the motor circuit. In order to prevent too sudden fluctuation upon the breakage of circuit, and to maintain regularity while the current is on, the main shaft is provided with a heavy fly or balance wheel whose momentum prevents irregularities, and causes gradual slowing down when the circuit is broken. As the circuit controling lever of the governor completes the circuit through an adjustable stop, the joint effects of the governor and fly-wheel are that the machine is capable of the finest adjustment, breaking and completing the circuit upon the least variation from a determined desired speed, acting exactly, so to speak, as an automatic cut-off in steam engines, preventing unnecessary consumption of energy.

The breaking of the main circuit occasions a large spark at the breaking point, which is more destructive as a unit than it would be if divided into several sparks, hence I break the main circuit, when breakage is necessary, at several points simultaneously in order to divide the spark and lessen its total injurious effect.

I accomplish this by fixing upon an insulating base several contact springs, the free ends of which rest each respectively upon proper contact posts, and project slightly beyond the same. The circuit is led to one post, passes to its spring, whence it passes by a wire to the next post and its spring, and by wire to the next post, and so on through the series of springs and posts. Either the circuit controling lever or the armature lever, as either is used for the purpose as before explained, is broadened at the end so as to take under the extreme free ends of all the circuit springs, and upon desired movement lift them from their posts, breaking the main circuit at a number of points.

In using electro motors, especially for actuating light machinery, it is very desirable that the rate of speed of the actuated machine be under control of the operator, and that the means of control be simple, effectual, and easy of application.

Hitherto this has been attempted only through controling the electric circuit to the motor, breaking or closing it in whole or in part. I propose to control the speed by the application of a brake to the main driven wheel without reference to the current. A brake is so pivoted as to be capable of bearing upon the wheel, but kept therefrom normally by a spring. Attached to the brake is a lever which

in turn is attached to a treadle, by means of which any desired pressure may be applied, though it is evident that the brake lever may be arranged to be operated by hand instead of through the medium of a treadle.

So far as I am aware electric motors have always been connected direct to the actuated machine, so that the rate of speed of the actuated machine and of the motor were the same. It is often desirable that the actuated machine be driven at a less or at a greater rate of speed than the motor. To effect this I interpose between the two differential gearing, that is, gearing which may be cogged wheels, pinion wheels, friction gearing, belts, and pulleys, *etc.*, of different diameters, arranging them to produce the desired differentiation of speed.

Referring now to the Drawings for a more particular description,

Fig. 1 is a detailed view of several parts detached from Fig. 2.

„ 2 is an isometric view of a machine embodying a portion of the improvements forming the Invention herein claimed.

Fig. 3 is a plan view.

„ 4, an end view, and

„ 5 a side view of a motor and actuated machine showing another portion of the Invention herein claimed.

a is a rotating armature which revolves between polar extensions of magnets not necessary to be shown. This armature is composed of a number of thin plates, rings, or disks secured upon the shaft *b*, thin pieces of insulating material, preferably tissue, alternating with the plates, rings, or disks, and separating each of them from all the others. The black lines at a^1 show the metallic plates, the intermediate white lines representing the insulating material. The plates, disks, or rings should not exceed one eighth of an inch in thickness, while the best results are obtained when the thickness is from one sixty fourth to one thirty second of an inch. *d*, *d*, are the commutator brushes or springs resting against the commutator d^2; these brushes are secured in stands d^3 capable of horizontal and vertical adjustment, as shown. As more clearly shown in Fig. 1 the springs or brushes are placed obliquely to the axis of the commutator, preferably at an angle of about 30°. The shaft *b* of the revolving armature and of the commutator is supported in boxes *c*, and is arranged to have a longitudinal movement therein. Upon the end of the shaft *b* is fixed a disk *f*, which forms the armature for a magnet *m*; whose poles *p*, *p*, are extended, as shown, to exert their influence upon *f*. Through the magnet passes an electrical circuit *y*, *y*, in which is placed a circuit interrupter, consisting of a spring *u* whose free end bears upon a hub or disk *t*, whose surface is composed of alternate conducting and non conducting material, one or a series of alternations being used. While the spring *u* bears on a conducting portion of *t* the circuit through *m* is complete, and the poles *p*, *p*, attract *f*, pulling the shaft *b* to its limit of movement in one direction. When the circuit is broken a spring *s* forces the shaft to its limit in the opposite direction. The hub or disk *t* may be attached to any rotating part of a machine, or it may be driven by an independent motor. If it be so geared that its rate of speed is different from that of *b*, the movements of *b* will not occur at the same relative time in consecutive rotations, and the wear of the commutator will be evenly distributed over its whole face, and the rotating armature will also be evenly worn and polished. I prefer that mica be used as the insulating material between the metal bars or strips of the commutator. One circuit breaker *u*, *t*, may control the circuit for a number or battery of generators or motors; or a series of them may be arranged upon one shaft, each controling the circuit to a generator or to a motor, and arranged to operate in succession.

As before stated if an iron pulley be used upon the shaft *b* it may be so arranged that the attraction between it and the not shown magnets of the machine will move the shaft in one direction, the attraction between *f* and *p*, *p*, moving it in the other, in which case the spring *s* is dispensed with.

g is a centrifugal governor connected to the shaft *b* by a belt *q*; it is evident however that this governor may be placed on the shaft, or may be geared directly thereto. The sliding tube g^1 of the governor, raised or lowered by the action of

the governor balls, carries a shoulder *h* taking under a pivoted lever h^1, whose free end normally rests upon an adjustable stop *i*. The circuit *x*, *x*, of a small battery L B passes through the lever h^1 and stop *i*. This circuit *x*, *x*, also passes through an electro magnet l^1 whose armature lever *n* is pivoted in suitable standards 1, 2; the free end of this lever *n* is widened out into a plate which takes under the free ends of a series of circuit springs, in this case four in number o^1, o^2, o^3, o^4, which number however may be greater or less, as desired. These springs are attached to an insulating support p^1, and are arranged when not lifted by *n* to rest upon contact posts r^1, r^2, r^3, r^4. The motor circuit M C passes to the spring o^1 and post r^1, then by wire to spring o^2 and post r^2, and so through the series. The lever h^1 and part *i* are adjusted so that they shall remain in contact whenever a desired predetermined speed is not exceeded, but that h^1 shall be lifted from *i* when such speed is exceeded. In this latter event the circuit *x*, *x*, is broken between h^1 and *i*, the magnet l^1 is discharged, the armature lever *n* is raised by the force of its spring lifting the springs o^1, o^2, *etc.*, from their posts, and breaking at each the motor circuit *m c*. By this means a motor may be kept in action with a steady speed, and the destructive effects of one large main circuit spark lessened very materially by dividing into several minor sparks, or by increasing the number of springs and contact posts for breaking the main circuit any sensible spark effect may be entirely obviated.

If desired the battery L B, circuit *x*, *x*, and magnet l^1 may be dispensed with, and the springs o^1, o^2, o^3, o^4, *etc.*, be operated by the lever h^1.

Further, several magnets l^1 and armatures might be used, one being assigned for each spring, or for each division of two or more springs of the entire number used. In addition upon the shaft *b* is mounted a heavy fly or balance wheel F, W, whose momentum serves to avoid too sudden fluctuations in speed upon breaking the circuit.

In Figures 3, 4, and 5 a^1 is any suitable electro motor in which a^1 is the rotating armature, on whose shaft is a commutator d^2, upon which press the springs or brushes d, d, for completing the circuit from the conductors 1, 2, to the motor. Upon the shaft is the pulley b^1 secured thereto by friction, the friction being so adjusted that the pulley and shaft shall be held and move together when only the resistance of the actuated machine is to be overcome, but that whenever a greater resistance is offered the friction shall be overcome and the shaft rotate within the pulley without rotating it. From the pulley b^1 a belt b^2 leads to the large fly pulley b^3 secured to the frame of the actuated machine. Upon the shaft of b^3 is the pulley b^4, from which a belt b^5 transmits the motion to the actuated machine. Upon the underside of the table e^1, or to any convenient part of the frame, is pivoted a brake e^2, adjusted to be brought to bear upon the pulley b^4, but held normally from so doing by a spring *x*. To the brake e^2 is pivoted the rod e^3, which passes down and is connected with a treadle e^4 underneath the table.

Through this treadle then any desired pressure may be put upon the periphery of the wheel b^4, regulating its speed, the current to the motor remaining unaffected and its rotation continued. To the switch s^1 is attached a rod s^2 which passes to the front of the machine within easy reach of the operator. This switch is used to complete or break the circuit to the motor.

The switch may if desired be placed upon the frame or table of the actuated machine.

The form of the brake used may be varied; for instance, it may be a belt tightener, the belt b^5 being normally loose and the brake arranged to tighten it so that it will take upon the pulleys and transmit motion from one to the other.

What I claim is,—

First. A rotating armature, composed of thin metal plates, disks, or rings, as described, with alternating interposed insulating material, secured together upon a shaft or hub, substantially as set forth.

Second. The combination with a commutator of contact brushes or springs, arranged at an angle to the axis of the commutator, substantially as set forth.

Edison's Improvements in Electric Machines and Motors.

Third. The combination with the shaft of a commutator or rotating armature, or both, adapted to have a reciprocating movement in its supporting journals of means for giving such motion, substantially as set forth.

Fourth. The combination with a rotating shaft of a commutator or armature, or both, of an armature, a magnet, and a circuit controling device for giving a reciprocating motion to the shaft, substantially as set forth.

Fifth. The combination with a revolving armature of a governor receiving motion therefrom, and adapted to control the main circuit, substantially as set forth.

Sixth. The combination with a revolving armature of a fly or balance wheel, substantially as set forth.

Seventh. The combination with the main circuit of a circuit breaker, adapted to break or close the main circuit at several points simultaneously, as set forth.

Eighth. The combination with an electro motor of a brake applied to the main driven wheel, substantially as set forth.

Ninth. The combination with an electro motor of a friction pulley on the rotating shaft of the motor, and a brake applied to the main driven wheel and adapted to control its speed, substantially as set forth.

Tenth. The combination with an electro motor of a mechanical brake adapted to control the speed of the actuated machine, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal, this Seventeenth day of September, A.D. 1880.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
CHAS. H. SMITH, 140, Nassau St., New York.
GEO. T. PINCKNEY, " " " " "

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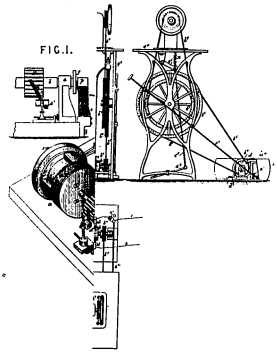
1880.

A.D.1880. APRIL 5. N°1385.
EDISON'S SPECIFICATION. (1 SHEET)

FIG. 4.

FIG. I.



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EDISON'S SPECIFICATION.

(1 SHEET)

FIG. 1.

FIG. 2.

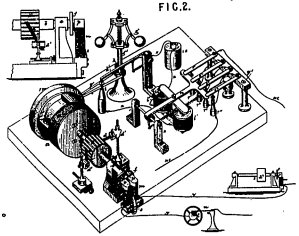


FIG. 5.

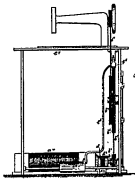


FIG. 4.

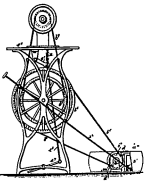
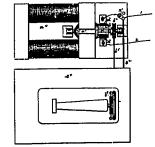


FIG. 3.



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A.D. 1880, 16th *September*. N° 3765.

Electric Lamps, &c.

LETTERS PATENT to Edward Griffith Brewer, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN CARBONS OR INCANDESCING CONDUCTORS THEREFOR, AND IN MEANS FOR AND METHODS OF MANUFACTURING THE SAME." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Edward Griffith Brewer at the Office of the Commissioners of Patents on the 16th September 1880.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN CARBONS OR INCANDESCING CONDUCTORS THEREFOR, AND IN MEANS FOR AND METHODS OF MANUFACTURING THE SAME." (A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.)

As is now generally known, the inventor prefers to use in his system of electric lighting an electric lamp consisting essentially of an incandescing conductor sealed hermetically in a glass enclosing globe.

In manufacturing carbons for such, and for all classes of electric lamps, the practice, so far as the inventor knows, has been to make them of as low resistance as possible, a porous carbon having been used which was dipped or soaked in some carbonizable liquid until its pores were filled and then subjected to recarbonization, which process was repeated until the pores of the original carbon were filled with carbon.

By this process the resistance of the carbon is lessened, while its liability to disintegration under high heat is increased.

Such carbons are unfit for use in electric lamps giving light by incandescence.

For such lamps the inventor has discovered that the incandescing material should have the highest possible resistance in a very small bulk, and be capable of resisting the disintegrating effects of very high heats in the absence of atmospheric pressure, and further that carbons, which are purely structural in character, alone possess these qualities. By purely structural is meant a carbon wherein the

A

[*Price* 1s. 2d.]

natural structure, cellular or otherwise, of the original material is preserved unaltered, that it is not modified by any treatment which tends to fill up the cells or pores with unstructural carbon, or to increase its density, or to alter its resistance.

One object of this Invention therefore is to provide such carbons, and means and methods for their manufacture.

In practice the incandescing conductor of a lamp should be of about one hundred ohms resistance, while this may be varied within certain limits; the resistance stated is a preferable one, and is a very high resistance compared to the carbons referred to as previously used.

It is essential that this high resistance should be had without increase of radiating surface, that is, only the radiating surface necessary to give a certain standard amount of light at the proper degree of incandescence should be used.

The inventor has discovered that incandescing conductors possessing the qualities enumerated may be made of such natural fibres or fibrous bodies as are capable of carbonization, especially such as are large, filamentary, and cellular in character. Of such there are several varieties, of some of which a single fibre or several fibres aggregated together artificially are used, of some a piece composed of numerous elementary fibres is used.

The inventor has found that the preferable single fibres are those of which jute, bast, manilla, hemp, and such like, are good types, the most preferable one being a fibrous grass from South America called "monkey bast" fibre, each blade of which is generally round and composed of a great number of elementary fibres held together by a natural cement or resin, which carbonizing locks all the elementary fibres together into a homogeneous filament. The treatment next herein described applies however to all the fibres of this class.

These blades vary somewhat in size and also are slightly tapering. It being necessary that the conductors should be of a uniform size are reduced, and also any other fibres varying in size to uniformity by passing them through a cutting die, which shaves off the extraneous matter; or a revolving cutter may be passed along the fibres, or they may be reduced in any other practical way.

When desired several blades of the above named grass, or several of any other natural fibres, may be taken, and after bunching them together they are dipped into a solution of sugar or other carbonizable liquid and then carbonized as one fibre, the carbonized cementing liquid binding them firmly together into a large filament of higher resistance, but of no greater radiating surface than the carbonized paper incandescing conductor heretofore described by the inventor.

Upon the ends of the fibre, whether simple or compound, are fixed prior to carbonization clamps made of any suitable carbonizable material, lignum vitæ, box wood, or equivalent, being well adapted therefor.

They may be made flattened or square, but preferably are cylinders.

A small hole is bored through the centre and the fibre inserted therein.

It is advantageous to moisten these inserted ends of the fibre with a solution of sugar or with other carbonizable liquid; pieces of platinum wire are inserted into the clamps. Upon carbonization the material of the clamps shrinks around and upon the wires and fibre, binding them tightly together, which result is aided by the carbonization of the liquid applied as before suggested to the inserted ends of the fibre.

Of course materials wherein the piece necessary to form a conductor is composed of a large number of fibres. The inventor has discovered that excellent results pertain to the use of the plants of the family arundenaria, or gigantic grasses, commonly known as bamboo or cane, or cane bamboo. In such the primary fibres making up the mass of the material extend from end to end parallel to each other, increasing the strength and obviating danger of breakage from cross or oblique grain.

Of the bamboo cane the hard glossy exterior is the best to use, and the softer or pithy interior part should be rejected.

To produce the best results in giving light it is essential that the carbon should be of uniform size throughout the portion that is to be rendered incandescent in order that radiating surface and resistance be regular and uniform, ensuring even heating and incandescence.

To accomplish this the cane, bamboo, or other material used is treated as follows and by the following means:—

The cane is split into pieces somewhat wider than necessary and the inner or pith portion removed. The material chosen (either the cane or bast, or other if desired) cut into strips is passed through a shaving device in which a cutting or shaving knife is fixed, the material being forced against the knife by a movable block provided with an adjustable stop screw, by which the distance of the block from the knife can be regulated, regulating in turn the thickness to be given to the slip.

In this device the slip or filament is shaved on both sides until the proper thickness is attained.

It is then placed in a clamp composed of two halves of a length equal to the desired length of the slip. In one half a shoulder or offset is made at a distance from the edge greater than the desired width, upon which one edge of the fibre rests, which is then clamped between the two halves and the protruding portion carefully shaved off, which may be done by hand or by a cutting blade moved by machinery.

On the opposite side of the clamp is an offset in one half at a distance from the edge exactly equal to the width to be given the slip.

As it is desirable to form the extended bearing upon which take the clamps securing the carbon to metallic conductors, homogeneous and in one piece with the body, provision is made therefor.

Upon the side last referred to of the clamps and at the ends are small projections of the exact shape and size to be given the broadened ends of the carbons.

The slip shaved upon both sides and one edge is transferred to the opening in the clamps, and the extra material shaved or cut off.

The slip is now of uniform size throughout its body and with enlarged ends formed upon it.

These enlarged ends are entirely upon one edge, instead of the enlargement being equally distributed upon both edges, as elsewhere shown.

This construction enables the slips when placed on edge, the straight edge, in the carbonizing flask to move therein, as they are contracted in the process of carbonization.

Good natural and purely structural carbons may be made of wood, as the wood is an example of the class of material alluded to, in which the mass of material is composed of a number of elementary fibres naturally bound together.

In all instances the wood is first to be formed into the shape of what is generally known in the inventor's system as the loop or "horse shoe" and then carbonized, and not to be subjected to any further processes which will tend to fill up its pores and alter its density or resistance.

The wood may be prepared by several methods; for instance, it can be shaped by cutting or stamping by a die.

A thin veneer of wood, preferably smoother and brought to the desired thickness, is taken and laid upon a mould or bed plate, a cutting die is then forced down upon it, cutting out a piece in the shape desired for the incandescing material, and with thickened ends for attachment to the clamps, or a number of veneers may be taken and secured together, and then cut into proper shape by a band, gig, or circular saw.

Another method is as follows:—

A block of wood is taken and cut or formed so that its centre shall be a web, bounded at the sides by thicker portions. The grain of the wood is from side to side, and the thickness of the web is about the desired breadth of the carbon.

From the block so fashioned pieces whose width approximates the desired thickness of the carbon are split, shaved, or cut off. These pieces are then

sufficiently softened by moisture and heat so as to be bent into a circular or horse shoe or oval form, and they are retained in such shape in a proper carbonizing flask and carbonized.

Another method is as follows:—

A block of wood is taken and cut in a milling machine or lathe for turning irregular forms until its shape is that of an elongated oval, of which about one third, including an end, is cut upon somewhat larger axis than the remainder in order to provide for the clamps.

The interior is then reamed out in a suitable machine, so that the block then resembles a series of carbon horse shoes with closed ends piled upon each other.

The length of the oval is with the grain of the wood.

The block is then split or sawed into very thin layers or strips, each forming ultimately one horse shoe carbon.

The slips are then carbonized, preferably in a nickel flask. After carbonization the greater portion of the broader end of the slip is cut off, leaving the horse shoe in shape for use. This broader end, which connects what are afterwards the ends of the horse shoe, may, if desired, be cut off prior to carbonization; but as the broader connecting end tends to support and keep in shape the portions afterwards forming the horse shoe, it is better to leave it on until after carbonization.

Either before or after carbonization, preferably before, and before the slips are sawed or split from the block, small holes are made in the broad end, through which pass the clamp screws.

It is desirable in manufacturing carbon slips or filaments of the styles generally known as the "horse shoe" carbons, for use as the incandescing conductors in electric lights, that they should be carbonized evenly and uniformly, and that their shape should be preserved that the carbonization should be effected without warping or twisting the body of the carbon.

As however the material contracts largely in the process of carbonization, means are required which, while holding the material in position to avoid twisting or warping, shall at the same time guarantee even and thorough carbonization, and permit the material to move, so that the inevitable contraction during the process may proceed without danger of rupturing or otherwise damaging the carbons.

The means and methods for this object are as follows:—

For fibres of the class where a single fibre is used and clamps are secured thereto a carbonizing flask is used, in the bottom of which is cut a groove approximating in form the shape desired for the finished carbon, but somewhat longer, in which groove is laid the fibre with its attached clamps. A heavy metallic cover is then laid thereon, confining the fibre in place, so that it preserves its shape during carbonization, while at the same time it is free to contract.

The cover may in turn be grooved and receive another fibre, and a series be used, so that many may be carbonized at once in one flask. This flask and all its parts should be made of nickel, which is best adapted to stand the high heats necessary to thorough carbonization.

The result is what is now known as the "horse shoe" carbon, made as a single fibre with carbon clamps and proper conductors securely attached thereto by the process of carbonization.

As these carbon clamps from their much larger size relatively contain a large quantity of deleterious gases, which come out very slowly when under the action of the vacuum pumps, it is preferable that clamps be used which have first been carbonized and subjected in vacuo to heat sufficient to produce a high degree of incandescence. When such are used a very small amount of sugar applied to the ends of the fibres serves, by its carbonization, to bind them securely together.

The carbons made of the other materials set forth have enlarged ends made upon them for offering a large and certain connection with the clamps, as set forth. For their carbonization a flask constructed in either of the following methods is used:—

These various forms are unitary in principle, in that they confine and support

the material during the carbonization, preventing any distortion, while at the same time provision is made for contraction, and they differ only slightly in the details by which these results are attained.

In one form a plate is provided with a groove or recess of the shape and size desired for the carbons. At one end of the groove is a recess just large enough to receive one of the enlarged ends of the strip, a pin being used to secure that end therein. At the other end of the groove is an elongated recess, the excess of length of which is equal to the contraction of the material during carbonization, in which rests the other end of the filament, to which may be attached, or on which may be placed, a small weight to keep it straight.

During carbonization this end is drawn up in its elongated recess, the other end remaining fixed.

In another form a groove or recess is made of the elliptical form desired with recesses at the ends just sufficient to admit of the enlarged ends of the filament placed sideways therein.

The top or apex of the groove is enlarged in this case, one boundary edge being upon a curve equal to the length of the uncarbonized material, while the other is of the length and shape desired for the filament after carbonization.

In another form a recess is cut in a plate of the form desired for the carbon, but of a size that will accommodate the uncarbonized material.

In the recess fits and slides a plate slightly smaller than the recess, so that when the plate is laid in the recess a groove is left sufficient in size to just receive the filament.

Upon the outer edges of the recess and at the proper points are made side recesses just large enough to receive the enlarged ends of the filament. The filament is laid in the groove formed between the recess and its plate, the enlarged ends laying in the recesses provided therefore, weights being laid upon the latter to confine them therein.

During carbonization, as these ends are fixed, contraction draws down the bow portion which carries the plate with it, the upper portion of the plate preserving the shape of the material.

The means described ensure the preservation of the proper shape of the material during carbonization.

It is also essential that they should be carbonized evenly and equally throughout their entire mass.

This may be accomplished by a furnace of the following description:—

Preferably a nickel flask is used composed of two parts, a base plate provided with numerous legs so as to support the same and permit the heat to reach the bottom, and a case, or which sets thereon. A series of plates constructed as before described is placed upon the bottom so as to form a pile, and the box or case placed thereon, its edges resting upon the bottom.

This flask is then placed in an oven of a size sufficient to leave a space on every side of the flask.

The oven is provided with a top in which is a peep hole having a removable cover for inspection of the interior.

A pipe connected to a source of supply of any gaseous combustible passes around the oven in several branches, inlet pipes therefrom carrying the gas in as many places as necessary to the interior of the oven for consumption there.

A pipe connected to a suitable air blast passes around the oven in the same manner, from which lead branch pipes, one passing into each inlet pipe of the gas supply, so that air under suitable pressure is mingled with the gas at the point of combustion, furnishing the proper blast for ensuring the necessary high degree of heat.

The gas and air pipes are furnished with proper valves, so that the relative supply of each may be regulated.

By this means the supply may be so regulated that at first the flask is subjected

to a comparatively moderate heat only, which is then gradually brought up to the highest degree necessary.

During the process of carbonization there is sometimes danger that the material under treatment may be oxidized to such an extent as to interfere with proper carbonization.

This oxidation is due to the oxygen in the air present in the flask, and to the oxygen eliminated from the wood itself at the commencement of the process.

If desired to prevent this, an auxiliary tube may be used, passing into the flask, through which is introduced therein prior to firing, and during the burning, an atmosphere of hydrogen, or of some hydro-carbon or of some other element which will take up the oxygen and prevent its action upon the filament.

In a system of electric lighting, such as proposed by the inventor, in which separate electric lamps devoid of regulating devices are used at the places of consumption, the entire regulation for all the lamps being performed at the central station, as with water or gas supply, it is essential that a constant electro-motive force or pressure be maintained.

And as in such a system the lamps are arranged upon the multiple arc or derived circuit system, it is essential that there should be a certain standard resistance in each derived circuit.

This has been attained by placing one lamp of such standard resistance in each derived circuit.

It is desirable that all lamps used should be of equal lighting value, each giving a certain standard amount of light.

This has been attained by giving each a certain definite or standard amount of radiating surface.

Ordinarily this radiating surface has been that with which the standard pressure or electro motive force and the standard resistance should give a light equal to 16 candles.

Sometimes however it is desirable in some part of the system to use lamps which each give a much less amount of light, for instance, in chandeliers, where it is desired to divide the total amount of light produced among a larger number of lamps than ordinary, that is, that the light of one standard, say, 16 candle lamp, be divided between two, three, or four lamps, each of eight, five, and one third or four candle power respectively.

This result may be obtained in the following way:—

In a derived circuit are placed two lamps, each being carefully provided with an incandescing conductor of one half the resistance and one half the radiating surface of the incandescing conductor of the standard lamp of the system.

A single circuit breaker is provided for both lamps, in order that both shall be turned off or on simultaneously.

When desirable, the two lamps may be arranged in one holder, which may form a bracket or a section of a group of lamps or of a chandelier.

Instead of two lamps as instanced, any number may be used, care being taken that the resistance of each be a fractional part of the standard resistance of one ordinary lamp, the denomination of the fraction being the number of smaller lamps in the one derived circuit.

In the lamp generally used in my system and referred to hereinbefore, the light is produced by the incandescence of a conductor in an hermetically sealed vessel; the incandescing conductor being the small carbon now generally designated as the "horse shoe carbon."

Such however are designed for small lamps, usually fifteen to eighteen candle power, and the conductor required therefor being small is hermetically sealed in glass.

When it is desired to produce on the same principle a much greater light, say, one hundred candles power, the conductor thereto must also be much larger.

While the inventor has succeeded in satisfactorily sealing somewhat larger

conductors hermetically in the glass, it is generally not so effective or desirable a method of passing large conductors into the bulb as where small conductors are used, wherefore there seems to be a necessity for some other method, which, in the case of large conductors, shall pass the conductors in the bulb of the lamp without contact with the glass thereof, and at the same time furnish an effective and lasting hermetical seal.

This the inventor has succeeded in doing by the employment in the lamp of two column of mercury sustained in tubes attached to the lamp bulb at ordinary barometric hight by the pressure of the atmosphere, and serving both as seals to preserve the vacuum in the lamp bulb, and as parts of the circuit through the incandescent conductors.

A glass globe or bulb is blown of proper size, having an annular opening in its base of a size to admit of the passage into the globe of an insulating base supporting the carbon.

After this base is put in the globe the annular opening is closed, and two tubes connecting with the interior of the globe are connected hermetically thereto of a length somewhat greater than the barometric column of mercury.

From the clamps of the carbon conductors pass one from each clamp into the proper tube.

The lower ends of the tubes are placed in proper mercury reservoirs insulated from each other, one reservoir being connected to one pole of the source of electricity, the other to the other pole.

The air being exhausted from the globe, the mercury rises in the columns or tubes forming a seal for the vacuum, and also forming a circuit to the conductors attached to the clamps.

The lamp is supported upon or by a frame, the standards of which are provided with adjusting screws, so that its height may be regulated on the levelling of the stand secured.

Hitherto in manufacturing the lamp the carbon, having been prepared from paper, wood, or other suitable fibre, was placed in the lamp, whose parts were then sealed, the lamp was then exhausted of air, a current being applied during the process of exhaustion, heating the carbon.

Prior to sealing in the lamp and the process of exhausting the completed lamp the carbons were not heated, and prior to heating any defects therein could not be discovered.

It is practicably impossible to produce all the loops or slips of absolute uniformity or homogeneity, or to carbonize all of them absolutely uniform throughout their entire mass.

When heated to redness, generally throughout their length, some show spots either less red or of a brighter red than the average of the carbons, indicating for the first time faults in the carbons.

Where there is a bad fault in the carbon a white incandescent appears determining the life of the lamp and also affecting its resistance.

Such lamps are unfit for use, and the entire cost of their manufacture has proved a loss.

The inventor now employs a simple and easy method and means of testing the carbons before they are put in the lamp proper, and so prevent defective or unsuitable carbons from being embodied in completed lamps, to be only thrown away upon discovery of the faults, increasing in fact the net cost of the faultless ones.

This is accomplished by a preliminary heating of the carbons in vacuum, which by the following means can be cheaply, rapidly, and effectually done.

What may be called a temporary lamp is formed of a globe or chamber of proper size, with an aperture at its top of a size sufficient to admit of the passage of a carbon and its supporting base. The neck of the supporting base passes tightly through a soft rubber cork which fits into the aperture in top of the globe. The cork is so sized that its upper side is a little distance below the top edge of the aperture, so that when the cork is in position a chamber is formed on top.

On one side of the wall of the aperture is an opening having a tube upon its exterior, the opening being into the chamber referred to as formed above the cork. A mercury reservoir is connected to the opening by a flexible tube.

When the cork is put into place the reservoir is elevated and the mercury flows thence, forming a seal over the cock, *per contra* the reservoir being depressed the mercury flows back into the reservoir, leaving the cork exposed.

The globe is connected to a proper exhaust tube, several springlo drops being simultaneously used.

By this means a carbon may be placed in the globe, and sealed and exhausted quickly, and the current applied for testing the carbon, and if found perfect it may be placed in a permanent lamp.

If the carbon proves defective it is discarded, the only loss being the labor and material, which are small, involved in the manufacture of the carbon, and not as hitherto, the material and great labor necessary to make a complete lamp.

It is evident that several carbons may be tested at once in the proving chamber or temporary lamp.

One of the objects in giving a very high resistance to the incandescing conductors used in my system of lighting is to attain economy of material in the conductors therefor.

The resistance usually given them is sufficient for any desired economy in ordinarily thickly settled localities. For use, however, in sparsely settled neighborhoods, as say, the outskirts or suburbs of a town or city, it may be desirable to have a lamp by the use of which still greater economy of conductor is attained.

In such localities, in order to lessen the number of lights needed in streets, it may be also desirable to have a lamp in which the volume of light is increased, in order that economy in the erection of lamp posts, for example, may be subserved, and it may also be desirable to use lamps in which the volume of light may be increased in other localities.

As there is eventually a limit to the effective life of the carbon used, it is desirable to so arrange a lamp that the operative life of the lamp may be prolonged beyond the average life of a carbon, to the end that the cost of the labor expended in embodying a carbon in a lamp may be reduced.

Both or either of these results are obtained in the following way:—

In a globe made and put together in the manner usually employed and hitherto described, two or more carbons are used.

In using two to the end of one conductor passing into and sealed in the globe is by its single limb fastened, a double clamp of Y shape to each of the double limbs, a carbon being attached. At their other end each carbon is attached to an individual clamp, each clamp being attached to a conductor passing and sealed into the globe.

The conductors (in this instance three in number) pass to a circuit closer connecting them to the conductor from the source of electricity.

This circuit closer is so constructed as to be capable of closing the circuit simultaneously through both, and so that, as desired, they may be either in one circuit, as a series, or each be in its own derived circuit, or the circuit may be closed through either one separately.

When both are used in multiple arc, it is evident that the net resistance of the circuit is one half the resistance of one, and a certain sized conductor is required.

If both are used in series the resistance is double that of one, and four times that of the multiple arc, in which case the conductor may be diminished three fourths.

As the volume of light is that of two ordinary lamps, it is evident that a much less number may be used with the same light giving results. Thus economy in laying main conductors and in the erection of lamps is secured.

It is evident that, as one carbon only may be used at a time, that by so using one only at a time, the life of a manufactured lamp is practically doubled, for where

one carbon has reached its effective limit the circuit there-through is transferred to the other, thus saving the expense involved in sealing one carbon in its globe, the cost of a globe, and its exhaustion.

It is evident that more than two carbons may be sealed in one globe, one conductor being provided with the corresponding number of clamps, and each carbon provided with a separate return wire, for which proper connections are made by enlarging the circuit closing key, on the principle shown.

In electric lamps formed by sealing an incandescing conductor hermetically in a glass enclosing globe, there may be danger sometimes that the glass and wire will separate at the point where the conducting wires pass through and are sealed into the glass globe. This is due to the fact that the conducting wires near the incandescing material become very hot by conduction, and that the co-efficient of expansion of the glass and wire are so different.

In the lamp made on this plan, owing to the high resistance of the incandescing material, such small conductors are used that the danger referred to has been of minor or the very least importance.

It may be desirable, however, to provide means which reduce the danger to a minimum, while affording at the same time the necessary support for the very small and delicate conductors and incandescing material.

To accomplish this, a small glass bulb is blown of a little larger diameter than the distance apart of the ends of the carbon.

Through this globe are passed and sealed therein the conductors leading to the carbon, each conductor being sealed therefore in two places, one contiguous to the clamps for receiving and supporting the carbon, the other seal being almost diametrically opposite.

The carbon and clamps being placed in position, this small globe is placed in an aperture left for the purpose in the larger enclosing globe, and sealed thereto at about the meridian line of the smaller bulb.

The larger bulb is provided with a tube by which it is attached to the air exhausting apparatus, and where it is sealed after the vacuum is produced; connected to this tube is a branch tube leading from the smaller bulb, so that both are simultaneously exhausted.

As very small small conductors are used, it is necessary for stability that they be supported near the carbon, which is done at the sealings on top of the smaller globe, but if either of these, from their proximity to the light, is over so heated as to crack, it will still subserve its function as a support, while the vacuum is preserved by the seals more distant from the clamps.

Sometimes it may be desirable to make a lamp in which a less permanent seal is used, involving a less expensive method of sealing, and which may be taken apart readily for the substitution of a carbon, or for other purposes.

This may be done as follows:—

Upon a tube closed at one end is supported a carbon, the conductors therefrom passing through the tube, and being sealed hermetically in the top thereof.

The enclosing globe is made with a neck somewhat larger than the tube, so that the carbon may be passed there-through.

A rubber packing is interposed between the outer walls of the tube and inner walls of the neck securing the two together, the ends of the tube projecting beyond the end of the neck.

This projecting portion of the tube passes through the base of a rubber cup, the base of the neck resting upon the bottom of the interior of the cup. At the top of the cup a rubber packing fills the space between the exterior of the neck and the interior of the cup.

The space in the cup is filled with mercury, which is retained in place in the cup by the packing last referred to, forming with the rubber a good seal for any temporary use.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Edward Griffith Brewer in the Great Seal Patent Office on the 16th March 1881.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex, "IMPROVEMENTS IN ELECTRIC LAMPS, AND IN CARBONS OR INCANDESCING CONDUCTORS THEREFOR, AND IN MEANS FOR AND METHODS OF MANUFACTURING THE SAME." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

As is now generally known said Edison prefers to use in his system of electric lighting an electric lamp consisting essentially of an incandescing conductor sealed hermetically in a glass enclosing globe.

In the manufacturing carbons for such and for all classes of electric lamps, the practice so far as known has been to make them of as low resistance as possible, a porous carbon having been used which was dipped or soaked in some carbonizable liquid until its pores were filled and then subjected to recarbonization, which process was repeated until the pores of the original carbon were filled with carbon.

By this process the resistance of the carbon is lessened while its liability to disintegration under high heat is increased. Such carbons are unfit for use in electric lamps giving light by incandescence.

For such lamps said Edison has discovered that the incandescing material should have the highest possible resistance in a very small bulk, and be capable of resisting the disintegrating effects of very high heats and the absence of atmospheric pressure, and further that carbons which are purely structural in character alone possess these qualities. By purely structural is meant a carbon wherein the natural structure, cellular or otherwise, of the original material is preserved unaltered, that is, not modified by any treatment which tends to fill up the cells or pores with unstructural carbon, or to increase its density, or to alter its resistance.

One object of this Invention therefore is to provide such carbons and means and methods for their manufacture.

In practice the incandescing conductor of a lamp should be of about one hundred ohms resistance. While this may be varied within certain limits the resistance stated is a preferable one, and is a very high resistance compared to the carbons referred to as previously used. It is essential that this high resistance should be had without increase of radiating surface, that is, only the radiating surface necessary to give a certain standard amount of light at the proper degree of incandescence should be used.

Said Edison has discovered that incandescing conductors possessing the qualities enumerated may be made of such natural fibers or fibrous bodies as are capable of carbonization, especially such as are large, filamentary, and cellular in character. Of such there are several varieties, of some of which a single fiber or several fibers aggregated together artificially are used, of some a piece composed of numerous elementary fibres are used.

The preferable single fibres are those of which jute, bast, manilla, hemp, *etc.*, are good types, the more preferable one being a fibrous grass from South America called "monkey bast" fibre, each blade of which is generally round and composed of a great number of elementary fibres held together by a natural cement or resin, which carbonizing locks all the elementary fibers together into a homogeneous filament. The treatment next herein described applies however to all the fibers of this class. These blades vary somewhat in size and are also slightly tapering. It being necessary that the conductors should be of an uniform size they are

reduced, and also any other fibers varying in size to uniformity by passing them through a cutting die which shaves off the extraneous matter, or a revolving cutter may be passed along the fiber, or they may be reduced in any other practical way.

When desired, several fibers of the above named grass or several of any other natural fibers may be taken, and after bunching them together dip them into a solution of sugar or other carbonizable liquid and then carbonize as one fiber, the carbonized cementing liquid binding them tightly together into a large filament of higher resistance, but of no greater radiating surface than the carbonized paper incandescing conductor heretofore patented by said Edison. So far as capable of illustration this part of the Invention is shown in Figs. 1, 2, & 3. Upon the ends of the fiber A, whether simple or compound, are fixed prior to carbonization, the clamps B made of any suitable carbonizable material, lignum vitae, box wood, *etc.*, being well adapted therefor. They may be made flattened or square, but preferably are cylinders. A small hole is bored through the center and the fiber inserted therein, as shown in Fig. 2. It is advantageous to moisten the inserted ends of the fiber with a solution of sugar or with other carbonizable liquid. Pieces of platinum wire *c*, *c*, are inserted into the clamps, as shown in Fig. 1. Upon carbonization the material of clamps B, B, shrinks around, and upon the wires and fiber binding them tightly together, which result is aided by the carbonization of the liquid applied, as before suggested, to the inserted ends of the fiber. Of those materials wherein the piece necessary to form a conductor is composed of a large number of fibers, excellent results pertain to the use of the plants of the family arundineria or gigantic grasses commonly known as bamboo or cane or cane bamboo. In such the primary fibers making up the mass of the material extends from end to end parallel to each other, increasing the strength and obviating danger of breakage from cross or oblique grain. Of the bamboo cane the hard glossy exterior is the best to use, and the softer or pithy part should be rejected.

To produce the best results in giving light, it is essential that the carbons should be of uniform size throughout the portion that is to be rendered incandescent, in order that the radiating surface and resistance be regular and uniform, ensuring even heating and incandescence. To accomplish this, the cane, bamboo, or other material used is treated as follows, and by the following means:—The cane is split into pieces somewhat wider than necessary, and the inner or pith portion removed. The material chosen (either the case or bast, or other if desired) cut into strips, is passed through a shaving device, in which a cutting or shaving knife is fixed, the material being forced against the knife by a movable block provided with an adjustable stop screw, by which the distance of the block from the knife can be regulated, regulating in turn the thickness to be given to the slip. In this device the slip or filament is shaved on both sides until the proper thickness is attained. It is then placed in a clamp composed of two halves, of a length equal to the desired length of the slip. In one half a shoulder or offset is formed at a distance from the edge greater than the desired width upon which one edge of the fiber rests, which is then clamped between the two halves, and the protruding portion carefully shaved off, which may be done by hand or by a cutting blade moved by machinery. On the opposite side of the clamps is an off-set in one half, at a distance from the edge exactly equal to the width to be given the slip. As it is desirable to form the extended bearing, upon which take the clamps securing the carbon to metallic conductors, homogeneous and in one piece with the body, provision is made therefor. Upon the side last referred to of the clamps and at the ends are made projections of the exact shape and size to be given the broadened ends of the carbons. The slip shaved upon both sides, and one edge is transferred to the opening in the clamps, and the extra material shaved or cut off. The slip is now of uniform size throughout its body, with enlarged ends formed upon it. The enlarged ends are entirely upon one edge instead of the enlargement being equally distributed upon both edges. This construction enables the slips when placed on edge, the straight edge in the

carbonizing flask to move therein as they are contracted in the process of carbonization. This part of the Invention is illustrated in Figs. 4, 5, 6, 7, and 8, in which Fig. 4 is a top view, and Fig. 5 is a side view of the device used for shaving the sides; Fig. 6 is an end view, and Fig. 7 is a side view of the clamps used in shaving the edges. Fig. 8 is a view of a complete filament.

In these Figures, A is a suitable base, having upon it supports *a*, *a*¹, for the working devices, these supports leaving an open space between them in which such working devices are mainly located. In front of *a*¹ is fixed a block B fashioned at one end to receive and support at the proper angle the knife or plane *b*. In front of *a* is a block C attached to screw D sliding in *a*, and caused to rotate so as to move C by disk E, working in a slot in *a*, D, being prevented from rotating by screw *d* taking into a feather cut in its side. Upon the side of C is lug G, through which passes the screw *g*, which is set to strike against B, and consequently limit the movement of C, keeping it at any desired distance from B, which distance is the thickness to be given the slip. The slip *s* is placed between B and C, and drawn through between them, being forced by C against the edge of the knife until one side is smoothed. It is then taken out and replaced with the shaved side next to *c*, and the operation repeated.

By these operations and means the slip is reduced to an uniform thickness.

The clamp for reducing to an uniform width is made of two parts H, I, of a length equal to the length to be given to the slip, and held together by pieces *z* one at each end, having a slot *o* in one end so as to permit of a limited movement of the parts H, I, from each other.

The part I is formed with shoulders or off sets *v*, *w*, along its entire length, taking into a corresponding recess in H, forming when the two parts are in position slots along the entire length of the clamp, the off sets *v*, *w*, forming the bottom of the slots. Upon one side at each end of each part are formed the lugs or projections *h*, *h*, the size and shape of the enlarged ends of the finished carbons. In *h*, *h*, the small recesses *i*, *i*, for the purposes hereinafter set forth.

The slip S of a greater width than the widest portion of the finished slip is placed in the clamp in the slot, whose bottom is the off set *v*, the clamps tightened and the protruding portion removed down to the surface of the clamps. The edge thus prepared forms a straight edge or gage for the finishing, the slip being placed in the clamp in the slot whose bottom is the off set *w*, and the extra material removed on the line formed by the surface of the clamp and the projections *h*, *h*. This being done a saw or knife is run through the recesses *i*, *i*. The result is the slip shown in Fig. 8 having an uniform body with the enlarged clamps for securing the carbon in the clamps, and provided with the recesses *i*, which are of use in securing the slip in the carbonizing flask, and afterwards for permitting the clamping screws to pass through. Sometimes it is desirable to form the ends thicker in both directions. In such cases the preliminary cutting in the first machine simply reduces the slip to dimensions equal to the desired width and thickness of the ends, and it is then finished off in the clamps, one set of clamps being made with shallow grooves so that the slip may be laid flatwise therein. Good natural and purely structural carbons may be made of wood, as wood is an example of the class of materials alluded to, in which the mass of material is composed of a number of elementary fibers naturally bound together. In all instances the wood is first to be formed into the shape of what is generally known in Edison's system, as the loop or "horse shoe," and then carbonized, and not to be subjected to any further processes which will tend to fill up its pores and alter its density or resistance.

The wood may be prepared by several methods, for instance, it can be shaped by cutting or stamping by a die. A thin veneer of wood properly smoothed and brought to the desired thickness is taken and laid upon a mold or bed plate, a cutting die is then forced down upon it cutting out a piece in the desired shape for the incandescing material, and with thickened ends for attachment to the clamps, or a number of veneers may be taken and secured together, and then cut

into proper shape by a band, jig, or circular saw. This is illustrated in Fig. 9, which is a section of the cutting die and mold with a veneer in position, and in Fig. 10, which shows the resultant piece ready for carbonization. In these Figures A is a cutting or stamping die provided with the cutting or stamping edge *a* projecting from the face of A, and of the same size and contour as the wooden horse shoe E; B is the mold or bed-plate having a groove or recess D, whose upper edge is of a size and shape just sufficient to receive *a*, but increasing in size towards the base to permit the ready escape of anything which may be forced in at the top. C is a piece of veneer in position for the operation of the stamp or die A. Upon force being applied to A shoe E is cut from the wood, with the broadened ends *e* for attachment to the clamps homogeneous and unitary therewith. This in then taken and placed in a suitable carbonizing flask fully illustrated herein. The result is a porous structural carbon of high resistance excellently fitted for use in lamps intended to give light by incandescence, and not needing any further treatment which might alter or modify its purely natural structure. Another method is as follows:—A block of wood is taken and cut or formed so that its center shall be a web bounded at the sides by thicker portions. The grain of the wood is from side to side, and the thickness of the web is about the desired breadth of the carbon. From the block so fashioned pieces whose width approximate the desired thickness of the carbon are split, shaved, or cut off. These pieces are then sufficiently softened by moisture and heat, so as to be bent into a circular, or horse shoe, or oval form, and they are retained in such shape in a proper carbonizing flask and carbonized. This method is illustrated in Figs. 11, 12, & 13, in which Fig. 11 represents a block formed as before described; Fig. 12, a piece split, cut, or shaved therefrom, and Fig. 13 the same after carbonization, in which A is the web of the block, the center of the block being reduced in thickness, while the ends *a*, *a*, are left broad or thickened for fastening to the clamps. This block is split, cut, or shaved into pieces like Fig. 12, which are then bent into the shape shown in Fig. 13, or into any other desired shape, and then carbonized while in such form. The result is a carbon with broadened ends for clamping unitary with itself, and which is porous, structurally unaltered, of high resistance, and with a minimum tendency to disintegration under high heat. It is evident that the block shown in Fig. 11 could be made of disintegrated fibers, paper pulp, papier mache, etc., by powerful pressure, and the individual carbons then cut off from such block; but in practice it is so far preferred to make the block and resultant carbons of wood. Another method is as follows:—A block of wood is taken and cut in a milling machine or lathe for turning irregular forms, until its shape is that of an elongated oval, of which about one third, including an end, is cut upon somewhat larger axes than the remainder in order to provide for the clamps. The interior is then reamed out in a suitable machine, so that the block then resembles a series of carbon horse shoes with closed ends piled upon each other. The length of the oval is with the grain of the wood. The block is then split or sawed into very thin layers or slips, forming ultimately one horse shoe carbon. These slips are then carbonized, preferably in a nickel flask or a description shown herein; after carbonization the greater portion of the broader end of the slip is cut off, leaving the horse shoe in shape for use. This broader end which connects what are afterwards the ends of the horse shoe may if desired be cut off prior to carbonization, but as this broader connecting end tends to support and keep in shape the portions afterwards forming the horse-shoe, it is better to leave it on until after carbonization. Either before or after carbonization, preferably before, and before the slips are sawed or split from the block small holes are made in the broad end through which pass the clamp screws. This is illustrated in Figs. 14, 15, and 16, of which Fig. 14 is a perspective view of the block partially turned in proper shape.

Fig. 15 is a front view of a carbon after carbonization; Fig. 16 is a side view of a carbon properly secured in clamps. In these Figures, A is a block of wood, which in a proper machine is turned so that its exterior shape is that of an oval composed of two ovals B, C, of different axes, thereby forming a broader portion

for the clamps, the interior being reamed out to present a uniform smooth surface F. This block so shaped is then split or sawed into very thin layers or slips of a thickness sufficient for one carbon horse shoe, as seen in Figs. 15 and 16. These slips are then carbonized and a portion of C broken or cut off at *c*, *c*, as shown in dotted lines in Fig. 15. At some stages in the process, preferably while in the shape shown in Fig. 14, holes *d*, *d*, are drilled for the reception of the screws *e*, which fasten the clamps D to the carbon. It is desirable in manufacturing carbon slips or filaments of the style generally known as the horse shoe carbons for use as the incandescing conductors in electric lights that they should be carbonized evenly and uniformly, and that their shape should be preserved, that the carbonization should be effected without warping or twisting the body of the carbon. As however the material contracts largely in the process of carbonization, means are required which, while holding the material in position to avoid twisting or warping, shall at the same time guarantee even and thorough carbonization and permit the material to move, so that the inevitable contraction during the process may proceed without danger of rupturing or otherwise damaging the carbons. For this purpose means and methods as follows are used:—

For fibers of the class where a single fiber is used and clamps or enlarged portions for clamps are secured thereto, a carbonizing flask is used, in the bottom of which is cut a groove approximating in form the shape desired for the finished carbon, but somewhat longer, in which groove is laid the fiber with its attached clamps. A heavy metallic cover is then laid thereon confining the fiber in place, so that it preserves its shape during carbonization, while at the same time it is free to contract. The cover may in turn be grooved and receive another fiber, and a series be used so that many may be carbonized at once in one flask. This flask and all its parts should be made of nickel, which is best adapted to stand the high heats necessary to thorough carbonization.

This flask is illustrated in Fig. 17, in which D is a flask or box of metal capable of withstanding a high degree of heat, having a groove E of the desired shape cut in its bottom, as shown in Fig. 17. As fibrous material contracts or shrinks in the process of carbonization, it is necessary to provide for the movement attendant thereon, care being taken at the same time to prevent any movement which would allow of warping or distortion. This is effected by the groove E which allows a longitudinal movement but prevents any other. In this groove the fiber with its attached ends is placed, a cover F being then laid over it. A corresponding groove may be cut in the upper surface of the cover F and another fiber laid therein, and a number of such covers, limited by the capacity of the flask or box D, may be used, so that many may be carbonized at one operation. When the flask or box D is full the lid F¹ is fastened tightly thereon, and the whole placed in any suitable furnace for carbonization. The result is what is now known as the horse shoe carbon made as a single fiber with carbon clamps and proper conductors securely attached thereto by the process of carbonization. As these carbon clamps from their much larger size relatively contain a large quantity of deleterious gases, which come out very slowly when under the action of the vacuum pumps, it is preferable that clamps be used which have first been carbonized and subjected in vacuo to heat sufficient to produce a high degree of incandescence. When such are used a very small amount of sugar applied to the ends of the fibers serves by its carbonization to bind them securely together.

The carbons made of the other materials set forth have enlarged ends made upon them for affording a large and certain connection with the clamps, as set forth. For their carbonization a flask constructed in either of the following methods is used:—These several forms are unitary in principle in that they confine and support the material during its carbonization, preventing any distortion, while at the same time provision is made for contraction, and they differ only slightly in the details by which these results are attained. In one form a plate is provided with a groove or recess of the shape and size desired for the carbon. At one end of the groove is

a recess just large enough to receive one of the enlarged ends of the strip, a pin being used to secure that end therein.

At the other end of the groove is an elongated recess, whose excess of length is equal to the contraction of the material during carbonization, in which rests the other end of the filament, to which may be attached or on which may be placed a small weight to keep it straight. During carbonization this end is drawn up in its elongated recess, the other end remaining fixed. In another form a groove or recess is made of the elliptical form desired, with recesses at the ends just sufficient to admit of the enlarged ends of the filament placed sideways therein. The top or apex of the groove is enlarged in this case, one boundary edge being upon a curve equal to the length of the uncarbonized material, while the other is of the length and shape desired for the filament after carbonization.

In another form a recess is cut in a plate of the form desired for the carbon, but of a size that will accomodate the uncarbonized material. In the recess fits and slides a plate slightly smaller than the recess, so that when the plate is laid in the recess a groove is left sufficient in size to just receive the filament. Upon the outer edge of the recess, and at the proper points, are made side recesses just large enough to receive the enlarged ends of the filament. The filament is laid in the groove formed between the recess and its plate, the enlarged ends laying in the recesses provided therefor, weight being laid on the latter to confine them therein. During carbonization as these ends are fixed, contraction draws down the low portion which carries the plate with it, the upper portion of the plate preserving the shape of the material. These plans may be better understood by reference to Figs. 18, 19, 20, 21, 22, 23, 24, 25, and 26, in which Figs. 18, 21, 24, and 25 are plan views of carbonizing plates, unitary in principle but differing slightly in detail. Figs. 20 and 23 are an edge and side view respectively of a slip or filament ready for carbonization. Figs. 19, 22, 26, and 27 are details more fully hereinafter referred to. A is the nickel plate in which is cut the groove *a* of the shape desired for the finished carbon, and of a depth sufficient to receive the slip or filament *s*.

The co-efficient of contraction of the fiber is determined by experiment, and the length of the groove is made equal to the length desired for the finished carbon, plus the contraction of the material during the process of carbonization. In Fig. 18 this extra length is at one end of the groove, enlarged at one end into a small chamber just sufficient to receive one of the enlarged ends *c* of the filament, which is secured therein by a pin *c*. A small wedge *f* may also be placed in the chamber to assist in keeping the enlarged end in shape, the pin *c* passing through *c* and *f*. The other end of the groove *a* is made with a long chamber *b*, whose length is equal to or greater than the amount of contraction in length of the filament in carbonization. Upon the free end of the slip or filament *s* the clamp *d* is secured.

The plate A with the slip or filament secured in position, as described, is covered by a smooth plate, or a series may be used piled one upon another, the smooth under surface of one forming the cover to the one underneath. They are then placed in a suitable nickel case, and on being subjected to the first low heat carbonization and contraction proceed evenly and equally throughout each slip or filament, the contraction drawing up the loose end in the chamber *b*, until at the conclusion of the process the end *d* is exactly opposite *c*. The cases and plates used are made of nickel as no other metal stands the high heat necessary in the final stage of carbonization.

In Fig. 21 the groove *a* is shown formed with a chamber a^1 at the bow of the horse shoe.

In this case the slip *s* is laid flatwise in the groove, the ends *c*, *c*, fitting into chambers at the end of the groove, upon which weights *c* are laid. By this means the ends are held in position during carbonization, while the contraction is from *a* to a^1 during the process. Fig. 24 shows the same construction and method of operation as in Fig. 18, except that while in Fig. 18 the slip is placed edgewise in the groove, in Fig. 24 it is placed flat or sideways in the groove. In Fig. 25

the plate A is formed with a chamber, in which slides a plate C smaller than the chamber by the size of the filament or strip, so that when the plate C is placed in the chamber a groove shall be left in which is placed the filament or strip, the ends *c*, *c*, resting in chambers fitted for them, and held in place therein by weights *g*, *g*, laid thereon, in chambers made therefor.

As the filament is thus fastened at the ends, as carbonization proceeds the ensuing contraction pulls the bow towards the ends forcing the plate C towards the end B of A. In all these plans, however, the filament is kept under strain during carbonization with one or more points fixed against moving, and the contraction proceeds against the strain which constantly keeps the filament against or in contact with a former, preserving its shape and obviating any risk of warping or twisting. In all provision is made for keeping flat and in their proper relative position the enlarged ends of the carbon.

It is also essential that they should be carbonized evenly and equally throughout their entire mass. This may be accomplished by a furnace of the following description:—Preferably a nickel flask is used composed of two parts, a base plate provided with numerous legs so as to support the same and permit the heat to reach the bottom, and a case or box which sets thereon. A series of plates, constructed as before described, is laid upon the bottom so as to form a pile, and the box or case placed thereon, its edges resting upon the bottom. The flask is then placed in an oven of a size sufficient to leave a space on every side of the flask. The oven is provided with a top, in which is a peep-hole, having a removable cover for inspection of the interior. A pipe connected to a source of supply of any gaseous combustible passes around the oven in several branches, inlet pipes therefrom carrying the gas in as many places as necessary to the interior of the oven for consumption there.

A pipe connected to a suitable air blast passes around the oven in the same manner, from which lead branch pipes, one passing into each inlet pipe of the gas supply, so that air under suitable pressure is mingled with the gas at the point of combustion, furnishing the proper blast for ensuring the necessary high degree of heat. The gas and air pipes are furnished with proper valves, so that the relative supply of each may be regulated. By this means the supply may be so regulated that at first the flask is subjected to a comparatively moderate heat only, which is then gradually brought up to the highest degree necessary.

The carrying into effect of this part of the Invention may be more clearly understood by reference to Figs. 28, 29, and 30, of which Fig. 28 is a view of a carbonizing plate grooved to receive a filament; Fig. 29 is a perspective view of a series of the plates in the carbonizing flask; Fig. 30 is a perspective view of the carbonizing oven. In these Figures, A is a carbonizing plate grooved to receive a filament, and to have it secured therein. The carbonizing flask is composed of two portions, B and C; B is a base provided with numerous legs *b*, *b*, *b*, *b*, in order to raise it above the bottom of the oven to permit the free passage of heat there around. Upon B is arranged a series of the plates A, each containing a filament, and over the series is placed a cover C, securing them all upon the base and within the flask. The flask so filled is placed within the oven D, provided with the cover E, an exit *e* for the escape of the products of combustion being provided. A peep hole may be provided, which is closed by cover F, through which the condition of the flask may be observed. A pipe G, connected to a source of supply of any gaseous fluid, passes around the oven in several branches, inlet branches *g*, *g*, therefrom conveying the gas in as many places as necessary to the interior of the oven for consumption; H is an air tube connected with a suitable blast and passing around the oven in the same manner as G, from which lead branch pipes *h*, *h*, *h*, one passing into each branch inlet *g*, so that air under pressure is mingled with the gas at the point of combustion, furnishing a supply of air for proper combustion, and ensuring the necessary high degree of heat. Both G and H are provided with ordinary stop cocks or valves, by which the supply of either air or gas absolutely or relatively to each other may be regulated. The oven D is of such a size that

when the flask is placed in position therein there is a space on every side between the flask and the oven. The flask, filled with plates and filaments, is placed in the oven and the fire kindled by lighting the gas. By means of the valve before mentioned, the supply of fuel may be so regulated that at first the flask is subjected to a moderate heat, which may be gradually brought up to the required point. The blast ensures a high degree of heat directed immediately upon the flask, and evenly distributed thereon.

When heated for a sufficient time the gas is turned off, and the flask may be allowed to cool down in the oven. During the process of carbonization there is sometimes danger that the material under treatment may be oxydized to such an extent as to interfere with proper carbonization. This oxydation is due to the oxygen in the air present in the flask, and to the oxygen eliminated from the wood itself at the commencement of the process. If desired to prevent this, an auxiliary tube may be used, passing into the flask, through which is introduced therein prior to firing, and during the burning, an atmosphere of hydrogen, or of some hydro carbon, or of some other element which will take up the oxygen and prevent its action upon the filaments.

In a system of electric lighting, such as proposed by said Edison, in which separate electric lamps devoid of regulating devices are used at the places of consumption, the entire regulation for all the lamps being performed at the central station as with water or gas supply, it is essential that a constant electro motive force or pressure be maintained. And as in such a system the lamps are arranged upon the multiple arc or derived circuit system it is essential that there should be a certain standard resistance in each derived circuit. This has been attained by placing one lamp of such standard resistance in each derived circuit. It is desirable that all lamps should be of equal lighting value, each giving a certain standard amount of light. This has been attained by giving each a certain definite or standard amount of radiating surface.

Ordinarily this radiating surface has been that with which the standard pressure or electro motive force and the standard resistance should give a light equal to sixteen candles. Sometimes however it is desirable in some parts of the system to use lamps which each give a much less amount of light; for instance, in chandeliers where it is desirable to divide the total amount of light produced among a larger number of lamps than ordinary, that is, that the light of one, say, standard sixteen candle lamp, be divided between two, three, or four lamps, each of eight, five and one third, or four candle power respectively. This result may be attained in the following way:—

In a derived circuit are placed two lamps, each being carefully provided with an incandescing conductor of one half the resistance and one half the radiating surface of the incandescing conductor of the standard lamp of the system. A single circuit breaker is provided for both lamps in order that both shall be turned off or on simultaneously. When desirable the two lamps may be arranged in one holder, which may form a bracket or may form a section of a group of lamps or of a chandelier. This part of the Invention is shown in Figs. 31, 32, and 33, wherein Fig. 31 is a diagram showing one standard lamp and two half lamps in derived circuits from the same main conductors; Fig. 32 is a view of two half lamps arranged in one holder; and Fig. 33 is a diagram showing the connections in such holder. In these Figures C, C', are the main conductors leading to and from any suitable source of electric energy at the central station. In the multiple arc thereto is a lamp A of standard resistance and radiating surface. In the multiple arc 2 are the two lamps B, B, each of which has just one half the radiating surface and one half the resistance of A. One circuit breaker *b* is provided controlling the circuit through both lamps. As a consequence, with an uniform standard electro motive force or pressure, each of these lamps will each give one half the light which A would give. If it is desired to increase the number the same proportion between the number used and the standard resistance and radiating surface should exist. For two, three, or more lamps a suitable holder F of insulating material is

made, sockets *s* being made therein for each lamp. To each socket metallic conducting plates are placed on opposite sides, as at *c*, c^1, d, d^1, for forming contact with metal slips or pieces on the necks of the lamps. The socket may be provided with a plain or screw threaded aperture E, by which it may be attached to the wall as a bracket or to a framing so that it may constitute a portion of a group of 5 lamps or of a chandelier. Upon the socket is a circuit breaker consisting of a metallic screw D secured in a seat *h*, and which may be turned to impinge upon or be cleared from contact with a metal block *e*. The conductor C passes through *c*, c^1, to *e*, and the conductor C^1 through *d*, d^1, to the metal seat *h* of the screw D.

Instead of two lamps as instanced, any number may be used, care being taken 10 that the resistance of each be a fractional part of the standard resistance of one ordinary lamp, the denominator of the fraction being the number of smaller lamps in the one derived circuit. If more than two are used, the block *e* and screw D are placed somewhere in the circuit, leading through all the lamps in order that all may be turned on or off simultaneously, all the divided lamps being used as one 15 standard lamp. In the lamps generally used in said Edison's system, and referred to herein before, the light is produced by the incandescence of a conductor in an hermetically sealed vessel, the incandescing conductor being the small carbon now generally designated as the "horse shoe carbon." Such, however, are designed for small lamps usually, say, fifteen to eighteen candle power, and the conductor 20 required therefor being small is hermetically sealed in glass. When it is desired to produce on the same principle a much greater light, say, one hundred candle power, the conductor thereto must also be much larger. While said Edison has succeeded satisfactorily in sealing somewhat larger conductors hermetically in the glass, it is generally not so effective or desirable a method of passing large conductors into the 25 bulb as where small conductors are used. Wherefore, there seems to be a necessity for some other method, which in the case of larger conductors, shall pass the conductor into the bulb of the lamp without contact with the glass thereof, and at the same time furnish an effective and lasting hermetical seal. This is accomplished by the employment in the lamp of two columns of mercury sustained in tubes 30 attached to the lamp bulb at ordinary barometric hight by the pressure of the atmosphere, and serving both as seals to preserve the vacuum in the lamp bulb and as parts of the circuit through the incandescent conductors. A glass globe or bulb is blown of proper size, having an annular opening in its base of a size to admit of the passage into the globe of an insulating base supporting the carbon. After this 35 base is put in the globe, the annular opening is closed, and two tubes connecting with the interior of the globe are connected hermetically thereto, of a length somewhat greater than the barometric column of mercury. From the clamps of the carbons, conductors pass one from each clamp into the proper tube. The lower ends of the tubes are placed in proper mercury reservoirs insulated from each other, one reservoir 40 being connected to one pole of the source of electricity, the other to the other pole. The air being exhausted from the globe, the mercury rises in the columns or tubes, forming a seal for the vacuum, and also forming a circuit to the conductors attached to the clamps. The lamp is supported upon or by a frame, whose standards are provided with adjusting screws, so that its hight may be regulated, or the leveling 45 of the stand secured.

This part of the Invention is shown in detail in Fig. 34, which is a view of a lamp embodying this part of the Invention, shortened somewhat in proportion to its hight, as indicated in the dotted line. A glass globe or bulb A is blown, having an annular opening in its base of a size to admit of the base *a*, *a*, passing there- 50 through. The line of this opening is indicated at *i*, *i*. Upon the top of the bulb is formed a tube, the continuation of the projection N by which the lamp is attached to the air pump. Upon a suitable base *a*, *a*, of insulating material are fastened by proper devices, the clamps *b*, *b*, holding and supporting the horse shoe B, the clamps being connected to metallic conductors *c*, c^1, passing a little distance, say, several 55 inches, below the base *a*, *a*. Two glass tubes *c*, c^1, each of a diameter several times greater than that of *c* or c^1, and several inches longer than a column of mercury

supported in vacuo by atmospheric pressure, are united near their top as at *m*, and their united tops formed into a circle, the diameter of or slightly larger than the diameter *i*, *i*, of the opening in A. The base *a*, *a*, supporting the carbon and with its attached conductors is introduced into A, and the tubes *c*, c^1, are then secured by sealing at *i*, *i*, to A; the conductor *c* projecting downwardly into *c*, and c^1 into c^1.

For supporting the lamp thus formed a stand is employed consisting of an insulating top E and base E^1 united by metallic standards F, F^1, which are connected to the base E^1 by adjustable screw connections *g*, g^1, so that, as circumstances require, the top may be raised, lowered, or inclined. Upon the metal standards F, F^1, are binding screws, whereby conductors 1, 4, to and from the source of electricity are attached. The top E is provided with a central aperture, or it may be annular, permitting the tubes *c*, c^1, to pass through and below it while supporting the globe. Upon the base E is located a vessel made of insulating material not affected by mercury divided into compartments D, D^1, or two separate distinct vessels may be used.

The tube *c* passes into one D to near its bottom, while *c* passes into D^1. A wire 2 connects D and F and a wire 3 connects D^1 and F^1. The parts being placed in position, as shown in the Figure, the vessels D, D^1, are filled with mercury, and the tube continuation of N, before mentioned, fastened to the pump.

As the air is exhausted from the bulb the mercury rises in *c* and c^1. During this operation care must be taken that the compartments D, D^1 are kept supplied with mercury and that upon the completion they are still full. Upon the proper degree of vacuum being attained the bulb is sealed at N and the tube removed. At this stage the mercury has risen to and remains at *x*, *x*, the hight at which atmospheric pressure sustains a column of mercury in vacuo, the mercury contacting with *c*, c^1, and passing a little distance above their ends. The columns C, C^1, should be of such a diameter as to give no greater resistance to the current than does either of the conductors *c*, c^1, 2 or 3.

For high candle power incandescent lamps this arrangement makes a very reliable and durable seal, obviating any danger there may be of seal breakage arising from difference of expansion coefficient likely to exist where a large metallic conductor is sealed directly to or in glass. For such reason in large lamps this method may prove preferable to that of sealing direct.

Hitherto in manufacturing the lamp the carbon having been prepared from paper, wood, or other suitable fiber, was placed in the lamp, whose parts are then sealed; the lamp was then exhausted of air, a current being applied during the process of exhaustion heating the carbon.

Prior to sealing in the lamp and the process of exhausting the completed lamp the carbons were not heated, and prior to heating any defects therein could not be discovered. It is practically impossible to produce all the loops or slips of absolute uniformity or homogeneity, or to carbonize all of them absolutely uniform throughout their entire mass. When heated to redness generally throughout their length some show spots either less red or of a brighter red than the average of the carbons, indicating for the first time faults in the carbons. Where there is a bad fault in the carbon a white incandescence appears, determining the life of the lamp and also affecting its resistance. Such lamps are unfit for use and the entire cost of their manufacture has proved a loss.

It is now proposed to furnish a simple and easy method and means of testing the carbons before they are put in the lamp proper, and so prevent defective or unsuitable carbons from being embodied in completed lamps to be only thrown away upon discovery of the faults, increasing, in fact, the net cost of the faultless ones. This is accomplished by a preliminary heating of the carbons in vacuo, which by the following means can be cheaply, rapidly, and effectually done. What may be called a temporary lamp is formed of a globe or chamber of proper size, with an aperture at its top of a size sufficient to admit of the passage of a carbon and its supporting base. The neck of the supporting base passes tightly through a soft rubber cork which fits into the aperture in top of the globe. The cork is so

sized that its upper side is a little distance below the top edge of the aperture, so that when the cork is in position a chamber is formed on top. On one side of the wall of the aperture is an opening having a tube upon its exterior, the opening being into the chamber referred to as formed above the cork. A mercury reservoir is connected to the opening by a flexible tube. When the cork is put into place the reservoir is elevated and the mercury flows thence, forming a seal over the cork; *per contra*, the reservoir being depressed, the mercury flows back into the reservoir baring the cork. The globe is connected to a proper exhaust tube, several sprengel drops being simultaneously used. By this means a carbon may be placed in the globe, it sealed and exhausted quickly, and the current applied testing the carbon, which standing the test may be placed in a permanent lamp.

Suitable mechanism for carrying this part of the Invention into effect is shown in Fig. 35, which is a sectional view of the preliminary proving or testing lamp, in which Fig. Q is the usual glass carbon support, which is sealed to the glass globe in the completed lamp at *r*. *a* is the carbon to be proved, secured thereto in the usual way. C is the temporary proving lamp, having at its upper end an aperture sufficiently large to admit the carbon and its support, and provided with a soft rubber cork B, through which the neck of the carbon support Q passes. The cork B fits tightly in the aperture, the sealing being further rendered secure by a mercury seal E, a mercury reservoir *d* being elevated when necessary, so that the mercury therefrom flows down through a tube *c* over the top of the cork. From the bottom of the proving lamp C proceeds two two tubes, one *u* connecting with a McLeod gage; the other tube *b* leads to and connects with the vacuum apparatus. In operation the carbon to be tested is placed in the proving chamber or lamp C, and the mouth hermetically sealed. The stop cock *x* in tube *b* is then opened, giving free communication between the chamber C and the vacuum apparatus. When the proper degree of exhaustion is attained circuit is closed through carbon *a*, heating it to incande-cence, causing defects if any to be visible. If the carbon proves defective it is discarded, the only loss being the labor and material, which are small, involved in the manufacture of the carbon, and not as heretofore the labor and materials, which were many times greater, necessary to a completed lamp. It is evident that several carbons may be tested at once in the proving chamber or temporary lamp.

One of the objects in giving a very high resistance to the incandescing conductors used in said Edison's system of lighting is to attain economy of material in the conductors therefor. The resistance usually given them is sufficient for any desired economy in ordinary thickly settled localities. For use however in sparsely settled neighborhoods, as, say, the outskirts or suburbs of a town or city, it may be desirable to have a lamp by the use of which still greater economy of conductor is attained. In such localities, in order to lessen the number of lights needed in streets, it may also be desirable to have a lamp in which the volume of light is increased, in order that economy in the erection of lamp posts, *etc.*, may be subserved; and it may also be desirable to use lamps in which the volume of light may be increased in other localities. As there is eventually a limit to the effective life of the carbon used, it seems desirable to so arrange a lamp that the operative life of the lamp may be prolonged beyond the average life of a carbon, to the end that the cost of the labor expended in embodying a carbon in a lamp may be reduced. Both or either of these results are attained in the following way:—An enclosing globe is used, made and put together in the usual manner, in the lamps herein described. To the inner end of one of the conductors leading into the lamp is fastened a double clamp, that is, one that is Y shaped, a carbon being fastened to each limb of the Y clamp. At the other end each carbon is fixed in an individual clamp, each clamp having its own conductor leading outside of the lamp. The wires leading out of the lamp and the wires leading from a suitable source of electricity are united at a circuit controling device, constructed so that it may close the circuit through either carbon, the circuit through the other remaining open; or it may close the circuit through both, as carbons in a series; or it may

close a circuit through each, the circuit through them being derived or multiple arc circuits. This part of the Invention is more clearly shown in Fig. 36, in which A is a glass globe, and B the supporting neck united at *a*, *b*. Through the neck B passes the conductors 6, 7, 8, which are sealed therein. Upon the inner terminal of 6 is the Y shaped clamp D, in each leg of which is fixed a carbon *c* or *g*. The other ends of these carbons are in separate clamps, *e* being fastened in the clamp *d* of conductor 8, and *g* in clamp *d'* of conductor 7. The conductors 6, 7, and 8 and the circuit conductors 5, 9, are connected to a key E composed of metal contact points 1, 2, 3, 4, and anvils *x*, *z*, *z*, as follows:—Circuit conductor 5 is connected to point 1, contacting with *x*, and to anvil *z*, on which 2 contacts, while 9 is connected to anvil *z*, with which both 3 and 4 may make contact. Conductor 6 is connected to anvil *x*; 7 to point 4, which contacts with *z*; and 8 to 2, which contacts with *z*; and to 3, which contacts with *z*. If points 1 and 3 be put in contact with their anvils *x*, *z*, a circuit is formed, 5, *via* 1, *x*, 6, D, *c*, *d*, 8, 3, *z*, 9, the circuit through *g* being open. If 1 and 4 be closed on *x* and *z*, the circuit is formed 5, *via* 6, D, *g*, *d'*, 7, 4, *z* to 9, the circuit through *c* being open, and *g* alone in circuit and use. If 2 & 4 be closed on *s* and *z*, the circuit is from 5, *via* 8, 2, 8, *c*, D, *g*, 7, 4, *z*, to 9, and both *c* and *g* are in one circuit, that is in series. If 1, 3, and 4, be closed on *x*, *s*, and *z*, the circuit is from 5, *via* 1, *x*, 6, to D, where two paths are formed, the current consequently dividing one circuit being D, *c*, 8, 3, *z*, to 9, the other D, *g*, 7, 4, *z*, to 9, both carbons being in circuit, but each having its own circuit, which is a derived one, so far as the main circuit is concerned. When both are used in multiple arc it is evident that the net resistance of the circuit is one half the resistance of one, and a certain sized conductor is required. If both are used in series the resistance is double that of one and four times that of the multiple arc, in which case the conductor may be diminished three fourths. As the volume of light is that of two ordinary lamps, it is evident that a much less number may be used with the same light giving result. This economy in laying main conductors and in the erection of lamps is secured. It is evident that as one carbon only may be used at a time, that by so using one only at a time, the life of a manufactured lamp is practically doubled, for where one carbon has reached its effective limit, the circuit therethrough is transferred to the other, thus saving the expense involved in sealing one carbon and its globe, the cost of a globe, and of its exhaustion. It is evident that while only two carbons are shown, that more may be sealed in one globe D, being provided with the same number of clamps, and each carbon provided with a separate return wire, for which proper connections are made by enlarging key E on the principle shown. It is also evident that E may be provided with lever contacts instead of the screw contacts used to explain the principle of this Invention.

In electric lamps formed by sealing an incandescing conductor hermetically in a glass enclosing globe, there may be danger sometimes that the glass and wire will separate at the point where the conducting wires pass through and are sealed into the glass globe. This is due to the fact that the conducting wires near the incandescing material become very hot by conduction, and that the co-efficient of expansion of the glass and wire are so different. In the lamp made on the plan herein aforementioned, owing to the high resistance of the incandescing material, such small conductors are used that the danger referred to has been of minor or the very least importance. It may be desirable, however, to provide means which reduce the danger to a minimum, while affording at the same time the necessary support for the very small and delicate conductors and incandescing material. One part of this Invention has for its object the provision of such means, which is done as follows:—A small glass bulb is blown of a little larger diameter than the distance apart of the ends of the carbon. Through this globe are passed and sealed therein the conductors leading to the carbon, each conductor being sealed therefore in two places, one contiguous to the clamps for receiving and supporting the carbon, the other seal being almost diametrically opposite. The carbon and clamps being placed in position, this small globe is placed in an aperture left for the purpose in

the larger enclosing globe, and sealed thereto at about the meridian line of the smaller bulb. The larger bulb is provided with a tube by which it is attached to the air exhausting apparatus, and where it is sealed after the vacuum is produced. Connected to this tube is a branch tube leading from the smaller bulb, so that both are simultaneously exhausted. This is shown in detail in Fig. 37, in which A is the glass enclosing globe formed with the tube *a* for attachment to the exhausting apparatus. A small bulb B is made attached to the supporting neck C, and formed with a tube *b*. Through the bulb B the conductors 1, 2, are passed and sealed therein, 1 being sealed at c, c^1, and 2 at c, c^1. The bulb B is then sealed into A at the lines x, x, and the tube *b* connected to the tube *a*, the bulb B practically forming the seal to A. The tube *a* is then connected to the exhaust apparatus. It is evident that a vacuum is created in both A and B. When a proper degree of exhaustion is reached the tube *b* is sealed off at y, after which the tube *a* is sealed off at x, x. The vacuum in globe A is thus protected by two sealings of each wire c, c, and c^1, c^1, to only one set of which is there any danger, c^1, c^1, the other set, c, c, from its distance from the heated portion of the lamp, never heating sufficiently to be affected. As very small conductors are used it is necessary for stability that they be supported near the carbon, which is done at the sealings c^1, c^1; but if either of these from their proximity to the light is ever so heated as to crack, it will still subserve its functions as a support while the vacuum is preserved by the seals c, c, more distant from the clamps. Sometimes it may be desirable to make a lamp in which a less permanent seal is used, involving a less expensive method of sealing, and which may be taken apart readily for the substitution of a carbon or for other purposes. This may be done as follows:—Upon a tube closed at one end is supported the carbon, the conductors therefrom passing through the tube and being sealed hermetically in the top thereof. The enclosing globe is made with a neck somewhat larger than the tube, so that the carbon may be passed therethrough. A rubber packing is interposed between the outer walls of the tube and inner walls of the neck, securing the two together, the ends of the tube projecting beyond the end of the neck. This projecting portion of the tube passes through the base of a rubber cup, the base of the neck resting upon the bottom of the interior of the cup. At the top of the cup a rubber packing fills the space between the exterior of the neck and the interior of the cup. The space in the cup is filled with mercury, which is retained in place in the cup by the packing last referred to, forming with the rubber a good seal for any temporary uses. Fig. 38 shows a lamp embodying this portion of the Invention. A is the enclosing globe made with a long neck A^1, through which may be passed the carbon B attached to clamps *b*, *b*, connected to conductors 1, 2, which are sealed in the top of a tube C at c, c, the tube C being somewhat smaller than the neck A^1. Around the base of C is a soft rubber plug D, which fits into the lower part of the neck A, forming a tight joint between the two, supporting C and the carbon in position in A^1 and A; F is a socket or cup through the bottom of which by a tight joint passes the end of C, the end of D resting in the cup. At the top of the cup a washer E of soft rubber fills tightly the space between A^1 and the inner wall of the cup F, the space in the cup being filled with mercury H or other suitable liquid. The lamp so put together is exhausted, and then sealed at *a* in the usual manner, the combination of the cup F, plugs or washers D and E, and the mercury H forming a reliable seal.

Having thus described the Invention, what is claimed is hereby declared to be as follows:—

First. An incandescing conductor formed of one or more carbonized natural fibers, substantially as set forth.

Second. A carbon clamp for uniting the incandescing and the metallic conductors formed of a carbonizable material, substantially as set forth.

Third. The method of uniting the incandescing and the metallic conductors, which consists in inserting both in clamps made of carbonizable material, and then carbonizing the whole together, substantially as set forth.

Fourth. The slip for carbonization having enlarged ends formed in one piece,

and homogeneous therewith upon one edge, or one side and one edge, the remaining edge and side being straight, substantially as set forth.

Fifth. The method of forming a slip or filament for carbonization, consisting in securing a blank in clamps or holders, having the configuration desired for the carbon, and shaving or cutting away the superfluous material, substantially as set forth.

Sixth. A slip or filament for forming on carbonization the incandescing conductor of an electric light made of bast or fiber, like cane and bamboo, substantially as set forth.

Seventh. A slip or filament for forming by carbonization the incandescing conductor of an electric light made of a material composed of fibres laying parallel through the length of the slip or filament, substantially as set forth.

Eighth. A slip or filament for carbonization provided with slots or holes in its enlarged ends for holding it in the carbonizer and for passage of the clamping screws when placed in a lamp, substantially as set forth.

Ninth. The combination of the shaving knife, the block C, and means for moving it, and the adjustable limiting screw, substantially as set forth.

Tenth. The clamp formed of two portions, one being provided with off-sets or shoulders forming the bottom of slots acting as straight edges or gages to the slip under treatment, substantially as set forth.

Eleventh. The clamp provided with slotted projections at the ends for forming the broadened or thickened ends of the slip and the slots therein, substantially as set forth.

Twelfth. The method of forming carbons for electric lamps, which consist in forming the wood into the shape desired for the carbon, and then carbonizing the same, substantially as described.

Thirteenth. The method of forming carbons for electric lamps, which consists in cutting or stamping from a veneer a piece of wood with thickened or broadened ends and of the shape desired, and then carbonizing the same, substantially as described.

Fourteenth. The horse-shoe with thickened or broadened ends for attachment to the clamps formed or cut from one piece of wood, substantially as set forth.

Fifteenth. The method of forming carbons for electric lamps, which consists in shaping a block of wood as described, then cutting, splitting, or shaving into straight pieces adapted for single carbons, then bending such pieces into the desired form, and carbonizing in such form, substantially as described.

Sixteenth. The block for the manufacture of carbons for electric lamps, consisting of the central web and thickened or broadened ends, substantially as set forth.

Seventeenth. The method of forming carbons for the incandescing conductors of electric lights, consisting in first cutting or turning a block of wood into the shape of an oval having a broadened portion, then carbonizing, and then removing a portion of the broadened part, substantially as described.

Eighteenth. A carbon horse-shoe composed of a filamentary body with broadened ends turned from one piece of wood, and then carbonized, substantially as described.

Nineteenth. The method of manufacturing carbons for incandescent electric lamps, uniform and regular in shape and carbonization, consisting in carbonizing filaments while one or both ends are secured in a certain definite position relatively to the amount of contraction, so that when carbonized and contracted the ends shall be in proper position to each other, substantially as set forth.

Twentieth. The method of manufacturing carbons for incandescent electric lamps, consisting in maintaining the slips or filaments under constant strain, and with one or both ends fixed while in process of carbonization, substantially as set forth.

Twenty first. The method of manufacturing carbons for incandescent electric lamps, consisting in carbonizing the slips or filaments while in grooves, which maintain the shape and provide for contraction during carbonization, substantially as set forth.

Twenty second. The carbonizing plate provided with a groove for shaping the material, and a chamber or chambers permitting contraction during carbonization, substantially as set forth.

Twenty third. A carbonizing flask and the plates thereof made of nickel, substantially as set forth.

Twenty fourth. The carbonizing flask or box provided with grooves for the reception of the fiber, substantially as set forth.

Twenty fifth. The carbonizing oven consisting of a case and a system of gas and air supply pipes combined, substantially as described and for the purposes set forth.

Twenty sixth. The combination of a case or cover therefor provided with an inspection aperture and cover, means for supplying gaseous fuel to the interior of the case, and means for mingling air under pressure with the fuel, substantially as set forth.

Twenty seventh. The combination with one derived circuit of a multiple arc system of two or more lamps, each of a fractional resistance and radiating surface of the resistance and radiating surface of the standard lamp of the system, the fraction being the number used, substantially as set forth.

Twenty eighth. The combination with one socket or holder and one derived circuit of one circuit controller, and two or more lamps each of a fractional resistance and radiating surface of a standard lamp, substantially as set forth.

Twenty ninth. The combination with the incandescing conductor of an electric lamp, of two fluid columns sustained by atmospheric pressure, and forming both a part of the circuit and a hermetical seal to the lamp, substantially as set forth.

Thirtieth. The combination with the incandescing conductor and the fluid columns of reservoirs connected to the source of electricity, and into which the columns dip for the maintenance of the columns and the completion of the circuit therethrough, substantially as set forth.

Thirty first. The combination with an electric lamp of the stand or support therefor, consisting of an insulating base and top connected by adjustable standards, substantially as set forth.

Thirty second. The combination with a globe or chamber of a much larger chamber or reservoir connected to air exhausting apparatus, which maintains therein a high degree of exhaustion, substantially as set forth.

Thirty third. The combination of a proving chamber or globe, a mercury reservoir for sealing the same, and exhaust reservoir or chamber, and means for exhausting the same, substantially as set forth.

Thirty fourth. The combination of a globe or chamber, a second and much larger globe, chamber, or reservoir, a valved tube connecting them, means for maintaining a high degree of exhaustion in the larger reservoir or chamber and connected thereto, and a gage for determining the degree of exhaustion, substantially as set forth.

Thirty fifth. The combination with the globe or chamber of a proving lamp, of a mercury reservoir connected to the globe or chamber, so that the stopper thereof may at will be covered or not covered by mercury, substantially as set forth.

Thirty sixth. The method of testing carbons, consisting in subjecting them to the action of a current in a temporarily exhausted globe or receiver prior to their embodyment in completed lamps, substantially as set forth.

Thirty seventh. The combination in one electric lamp of two or more incandescing conductors, and means for connecting them in the electric circuit, either in series or multiple arc, substantially as set forth.

Thirty eighth. The combination in one electric lamp of two or more incandescing conductors, and means for making or breaking an electric circuit through either one as may be desired, substantially as set forth.

Thirty ninth. The combination in one electric lamp of two or more incandescing conductors, and means for completing the circuit through either, or through both, substantially as set forth.

Fortieth. The combination of contact points 1, 2, 3, 4, anvils x, s, z, and circuit connections, substantially as set forth.

Forty first. In an electric lamp, the combination with the enclosing globe or chamber of a second chamber through and into which the conducting wires pass and are sealed, both chambers being hermetically sealed together and exhausted, substantially as set forth.

Forty second. The method of sealing the enclosing globe or chamber of an electric lamp by sealing an auxiliary or secondary globe or chamber in the opening of the first or enclosing globe, substantially as set forth.

Forty third. The method of preserving the vacuum in the enclosing globe of an electric lamp, consisting in sealing the conducting wires at two points in a vacuum globe hermetically sealed to the enclosing globe, substantially as set forth.

Forty fourth. The combination with the neck of the enclosing globe and the carbon supporting tube of a cup containing a liquid receiving the end of the neck of the enclosing globe, and through which passes the carbon supporting tube, and washers or plugs filling the space between the neck and cup and the neck and tube, substantially as set forth.

In witness whereof, I, the said Edward Griffith Brewer, have hereunto set my hand and seal, this Fourteenth day of March, in the year of our Lord One thousand eight hundred and eighty one.

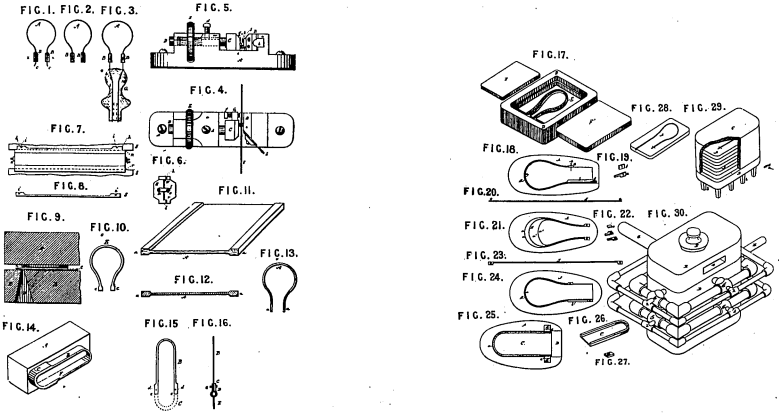
E. G. BREWER. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1881.

A.D.1880. Sep. 16. No. 3765.
BREWER'S Specification.

(2 SHEETS)
SHEET 1.



Nally & Sons, Photo-Litho.

London, Printed by George Edward Eyre and William Spottiswoode.
Printers to the Queen's most Excellent Majesty. 1881.

A.D.1880. Sep.16. № 3765.
BREWER'S SPECIFICATION.

(2 SHEETS)
SHEET 2.

FIG. 31.

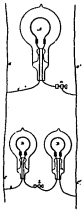


FIG. 32.

FIG. 33.

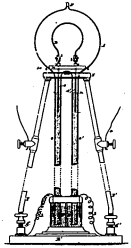


FIG. 35.

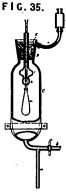


FIG. 38.

FIG. 37.

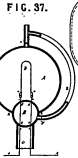
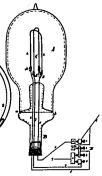


FIG. 36.



Malby & Sons, Photo-Litho.

London: Printed by George Edward Eyre and William Spottiswoode
Printers to the Queen's most Excellent Majesty. 1881.

A.D. 1880, 24th *September*. N° 3880.

Systems of Conductors for the Distribution of Electricity, &c.

LETTERS PATENT to Peter Jensen, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN SYSTEMS OF CONDUCTORS FOR THE DISTRIBUTION OF ELECTRICITY AS A LIGHTING AND MOTIVE POWER AGENT, AND APPLIANCES CONNECTED THEREWITH." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Peter Jensen at the Office of the Commissioners of Patents on the 24th September 1880.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN SYSTEMS OF CONDUCTORS FOR THE DISTRIBUTION OF ELECTRICITY AS A LIGHTING AND MOTIVE POWER AGENT AND APPLIANCES CONNECTED THEREWITH." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

Where many translating devices converting electricity into either power or light are arranged upon the multiple arc or derived circuit system, it is essential that so far as possible an equal electro motive force or "pressure" be maintained in all parts of the system.

When however each set of conductors are run out from the central station in a straight circuit containing a number of translating devices, the pressure, when a number of devices are in operation, is apt to be greatest nearest the central station, and to diminish gradually towards the end of the conductors, this "drop" being due to the resistance of the main conductors.

The object of this Invention is to obviate such irregularity, and to maintain practically throughout the entire system an equal pressure.

This I accomplish by using the conductors leading directly from the source of energy as feeding conductors only, placing no lamps ordinarily in the circuit connected directly to the source, placing the lamps or translating devices upon

[*Price* 6*d*.]

service or lamp circuits which connect to, and are fed by, the feeding conductors, in such manner that all the lamp circuits are electrically distant substantially from the source of electricity by the same mass of conductor. By so doing the greater portion, if not all, the drop occurs in the feeding conductors, the pressure in the service or lamp circuits being practically uniform at all points.

This invention may be carried into effect in several ways, of which the following are brief descriptions:—

One method consists in placing upon the conductors leading directly from the central station or source of energy no lamps, using such conductors only as feeding conductors to lamp circuit conductors, which they tap and feed into at their centres, such lamp circuit conductors being largest at their centres, and thence tapering to the ends, the lamps where many are to be used being placed in circuits derived from these lamp circuit conductors only.

From a central station several sets of feeding conductors may lead out, each feeding into its own set of lamp circuit conductors.

When it is desired to use a few lamps near the central station, they may be placed upon a direct circuit therefrom with resistance at the commencement or home end of the circuit, sufficient to then reduce the electro motive force of such circuit, so that it shall only be equal to that in the more distant circuits, and one or more of such circuits may be combined with the circuits before described.

When large buildings or blocks of buildings using many lamps are to be supplied, it may be desirable to lay therefor separate feeders insulated from each other.

While in this system it is preferred to use round metallic circuits, it is evident that by the introduction of proper grounds the earth may be used as half of the circuit.

It may be desirable in using round metallic circuits to add grounds as an aid to half the circuit, in which case such half the circuit may be of smaller conductors, provided its size be such that its resistance, added to that of the ground circuit, shall not exceed that of the other half of the circuit.

Where several central stations are used in a city, each having feeding conductors leading to lamp circuit conductors, of the description before noted, it may be advisable to connect the feeding circuits of all the stations, equalizing the electro motive force or pressure throughout the entire system of the place where the central stations are located.

Another method consists in laying the service conductor in squares around a central station, the sets of service conductors (positive and negative) in each set being concentric to each other, so to speak, feeding circuits leading to and connecting with each service set at several points.

The service sets may also be connected together at several points so as to aid in equalizing the pressure throughout the entire system.

In another method two conductors forming a complete metallic circuit are laid entirely around each square or block as the service conductors of such block. Feeding conductors from the source of electricity lead to and connect with the service conductors, but upon opposite sides, that is, one conductor, say, the one from the + pole connects at some point to one service conductor of a block, while the one from the − pole connects to the other service conductor at a point exactly opposite to the other, so that the terminals of all house circuits of a block, or the points where the house circuits connect to the service conductors, are all equidistant from the source, or that the same mass of conductor intervenes.

A series of blocks may be so arranged, the feeding conductors leading to the extreme or opposite blocks, one to each of the series, the service conductors of the blocks being united by cross conductors, so that each block is distant electrically from the source by the same mass of conductor.

Where a conductor varying in size throughout its length is used, it is preferable to make it a compound one, composed of several single wires of different lengths, one or two of which extend the whole length of the conductor, others

ending at various points. These wires are not insulated, but merely grouped in a bunch, which have transverse fastenings at intervals, or which may be fastened together by branch conductors passing around where connections are formed.

It is preferable to form all conductors which vary in size decreasing from some point in this manner, and it is to be understood in these descriptions that all such conductors are so made.

This system also contemplates the supply of electricity for both light and power. It is proposed that the current used for these purposes should be paid for at different rates, therefore where both power and light are desired two branch circuits are run from the mains into the house or locality of translation, one for the lights and one for the engines, a meter being placed in each.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Peter Jensen in the Great Seal Patent Office on the 24th March 1881.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN SYSTEMS OF CONDUCTORS FOR THE DISTRIBUTION OF ELECTRICITY AS A LIGHTING AND MOTIVE POWER AGENT AND APPLIANCES CONNECTED THEREWITH." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

Where many translating devices for converting electricity into either power or light are arranged upon the multiple arc or derived circuit system, it is essential that, so far as possible, an equal electro-motive force or "pressure" be maintained in all parts of the system.

When however each set of conductors are run out from the central station in a straight circuit containing a number of translating devices, the pressure when a number of devices are in operation is apt to be greatest nearest the central station, and to diminish gradually toward the end of the conductors, this "drop" being due to the resistance of the main conductors.

The object of this Invention is to obviate such irregularity and to maintain practically throughout the entire system an equal pressure.

This is accomplished by using the conductors leading directly from the source of energy as feeding conductors only, placing no lamps ordinarily in the circuit connected directly to the source, placing the lamps or translating devices upon service or lamp circuits, which connect to and are fed by the feeding conductors in such manner that all the lamp circuits are electrically distant substantially from the source of electricity by the same mass of conductor. By so doing the greater portion, if not all, the drop occurs in the feeding conductors, the pressure in the service or lamp circuits being practically uniform at all points.

This Invention may be carried into effect in several ways, of which the following are brief descriptions:—

One method consists in placing upon the conductors leading directly from the central station or source of energy no lamps, using such conductors only as feeding conductors to lamp circuit conductors, which they tap and feed into at their centers, such lamp circuit conductors being largest at their centers, and thence tapering to the ends, the lamps where many are to be used being placed in circuits derived from these lamp circuit conductors only.

From a central station several sets of feeding conductors may lead out, each feeding into its own set of lamp circuit conductors.

Where it is desired to use a few lamps near the central station they may be placed upon a direct circuit therefrom with resistance at the commencement or home end of the circuit, sufficient to then reduce the electro motive force of such circuit so that it shall only be equal to that in the more distant circuits, and one or more of such circuits may be combined with the circuits before described.

When large buildings or blocks of buildings using many lamps are to be supplied it may be desirable to lay therefor separate feeders insulated from each other.

While in this system it is preferred to use round metallic circuits, it is evident that by the introduction of proper grounds the earth may be used as half of the circuit.

It may be desirable in using round metallic circuits to add grounds as an aid to half the circuit, in which case such half the circuit may be of smaller conductors, provided its size be such that its resistance added to that of the ground circuit shall not exceed that of the other half of the circuit.

Where several central stations are used in a city, each having feeding conductors leading to lamp circuit conductors of the description before noted, it may be advisable to connect the feeding circuits of all the stations, equalizing the electro motive force or pressure throughout the entire system of the place where the central stations are located.

Another method consists in laying the service conductor in squares around a central station, the sets of service conductors (positive and negative in each set) being concentric to each other so to speak, feeding circuits leading to and connecting with each service set at several points. The service sets may also be connected together at several points so as to aid in equalizing the pressure throughout the entire system.

In another method two conductors forming a complete metallic circuit are laid entirely around each square or block as the service conductors of such block. Feeding conductors from the source of electricity lead to and connect with the service conductors, but upon opposite sides, that is, one conductor, say the one from the + pole connects at some point to one service conductor of a block, while the one from the − pole connects to the other service conductor at a point exactly opposite to the other, so that the terminals of all house circuits of a block, or the points where the house circuits connect to the service conductors, are all equidistant from the source, or that the same mass of conductor intervenes.

A series of blocks may be so arranged, the feeding conductors leading to the extreme or opposite block, one to each of the series, the service conductors of the blocks being united by cross conductors, so that each block is distant electrically from the source by the same mass of conductor.

Where a conductor varying in size throughout its length is used, it is preferable to make it a compound one, composed of several single wires of different lengths, one or two of which extend the whole length of the conductor, others ending at various points. These wires are not insulated but merely grouped in a bunch, which have transverse fastenings at intervals; or which may be fastened together by branch conductors passing around where connections are formed.

It is preferable to form all conductors which vary in size decreasing from some point in this manner, and it is to be understood in these descriptions that all such conductors are so made.

This system also contemplates the supply of electricity for both light and power.

It is proposed that the current used for these purposes should be paid for at different rates. Therefore where both power and light are desired two branch circuits run from the mains into the house or locality of translation, one for the lights and one for the engines, a meter being placed in each.

The foregoing may be better understood by a reference to the Drawings, in which are given diagrammatic representations of circuits, in which—

Fig. 1 illustrates a plan wherein the conductors are made larger at their home ends, gradually tapering to the outer end of the system.

When such plan is used, it is preferable to make each conductor a compound one, composed of several single wires of different lengths, one or two of which extend the whole length of the conductor, others ending at various points, as shown in Figure 1ᵇ. These wires are not insulated but merely grouped in a bunch, which have transverse fastenings at intervals, or which may be fastened together by branch conductors passing around where connections are formed, as shown in Figure 1ᵃ.

It is preferable to form all conductors which vary in size decreasing from some point in this manner, and it is to be understood in these descriptions that all such conductors are so made.

In Fig. 2 feeding conductors 1, 2, lead from central station *c*, *s*, connecting with the lamp circuit 3, 4, at about its center, the conductors of the lamp circuit being largest at that point, and also larger capacity at that point than the feeding conductors.

By this arrangement most of the fall of pressure or "drop" takes place in the feeding circuit, so that it cannot affect any lamps, while the "drop" in the lamp circuit is reduced very low, the "drop" from the center of the lamp circuit to either terminal being only about one fourth what the drop would be from y to z, if either end were connected directly to the central station.

Any desired number of lamp circuits may be so arranged, each having its proper feeding conductors, two so arranged being shown in Figure 3.

In some instances, when it is desired to use a few lamps near the station, they may be placed directly upon main conductors and combined with the circuit, shown in Figures 2 and 3, as shown in Fig. 4, where feeders 5, 6, connect with lamp circuit 9, 10, arranged as in Figures 2 and 3, while circuit 1, 2, connected directly to c, s, has a few lamps upon it, in which case a resistance should be used therein to lessen the electro motive force in 1, 2, to the same extent as it is lessened by the longer conductors 5, 6.

With such arrangement may also be combined an ordinary terminal circuit 15 containing a few lamps, such as the circuit 13, 14, in Fig. 5.

In Figure 6 is shown direct or main feeding circuits 1, 2, and 5, 6, with lamp circuits 3, 4, and 9, 10, with branch feeders 7, 8, 15, 16, and 21, 22, leading into side streets supplying lamp circuits 17, 18, 19, 20, 23, 24, and 25, 26, the branch feeders being derived circuits from the main feeders, all constituting a multiple arc system. In Figure 7 feeding mains 1, 2, connect to the center of the lamp circuit 3, 4, while feeders 5, 6, leading to a greater distance and to a circuit where comparatively few lamps are required, connects to the end of lamp circuit 9, 10, whose conductors gradually taper from the point of connection. This arrangement is sometimes desirable in sparsely settled localities as involving economy in the laying of conductors.

In Figure 8 is shown feeding conductors 1, 2, from which lead house feeders a, b, which connect to lamp circuit a^1, b^1, which are of same description as circuits 3, 4, Figure 2. Figure 9 shows a series of houses or buildings c, d, e, f, to each of which leads a feeding circuit of insulated conductor, the lamp circuit of each house being thereby put in direct connection with the central station c, s, the electro motive force of any one lamp circuit not being affected by the others. In Figure 10 are two blocks of buildings A, B, composed each of several houses h, h, h, separate feeding circuits 1, 2, and 3, 4, leading to branch feeding circuits from which lamp circuits lead into each house, each house or lamp circuit being provided with its own connection and meter. In the arrangement shown in Figures 8, 9, 10, the greater portion of the fall or drop occurs in the conductors leading to the house or block lamp circuits, the force or pressure in the branches leading into the houses being maintained practically uniform thereby in each lamp circuit. In Figure 11 is illustrated the substitution of ground G, G, for one conductor, say 2 of Figure 1, of the feeding conductors, a common ground being provided for all the lamps in one house lamp circuit.

In Figure 12 is shown a complete metallic feeding circuit 1, 2, in which grounds G, G, are added as auxiliary to the portion 2 of the circuit.

While ordinarily a metallic circuit is to be prepared, by adding grounds one portion of the circuit may be of smaller conducting capacity, thus tending to economy of conductor; care should be taken that the capacity of 2, however, is such that its resistance and that of the grounds be not greater than that of the portion 1 of the circuit.

In Figure 13 is shown a series of central stations c, s, from each of which lead main feeding circuits M (which may be of any desired number), each connecting to and feeding into a lamp circuit l, c.

The mains of all the stations are connected by conductors n, n, n, so that all the stations are electrically connected into one general system, whereby the pressure throughout the entire system is equalized.

In Figure 14 a house circuit s branches from the main circuit 1, 2, the circuit s branching into two circuits, on one of which all the lamps are placed, the other

being a motor circuit only, as shown, in each of which meters are placed, so that the amount of current used for each purpose may be determined. In Figure 15 the lamp circuit L, C, is fed by a number of feeding circuits, connecting thereto on opposite sides alternately 1, 2, 3, 4, and 5, 6, forming three feeding circuits, by which arrangement a comparatively uniform force or pressure may be maintained throughout the entire system. Figures 16 and 17 illustrate the method of laying the service conductors around blocks with feeding conductors leading thereto from the central station. C, S, is the central station, around which following the general direction of the blocks or squares of the locality are laid the sets of conductors 1, 2, 3, etc., so that they are, so to speak, concentric with each other. From the central station branch conductors lead to each of the main sets 1, 2, 3, at a number of points, for instance a, a^1, lead to set 3; b, b^1, to 2; c, c^1, to 1. In Figure 16 eight sets of branch conductors are shown leading to each of the main sets.

In Figure 17 two sets of main conductors 1, 2 are shown connected to the main station by four sets each of branch conductors b, b^1, c, c^1, differing however from Figure 1 in that the main sets 1, 2, are connected together by numerous sets of coupling conductors d, d^1.

As proceeding from the central station each set of main conductors traverses a larger area of territory, and has a larger amount of work to do, if all the conductors were of the same size there would be increased resistance. It is desirable however that each (no lamps on branch conductors or couplers) set should be of the same resistance, and that the same ratio of resistance of conductors to translating devices should exist in all the sets. This is accomplished by increasing the size of the conductors as they are laid further away from the central station.

Having determined the relative resistance which should exist between the resistance of the conductors and that of the sum of the translating devices most profitably to be used with such conductors, the increase of size to be given is that which shall preserve such ratio, taking into consideration the increased length of conductors and the increased number of devices to be probably supplied thereby. By this method of laying and uniting the conductors an equal pressure or electro motive force may be maintained throughout an entire system. Figures 18, 19, 20, and 21 illustrate modifications of the last described system, which may be called the block or square system. In these Figures A is a central station, at which is located a suitable source of electricity, and from which lead feeding conductors 1, 2; B represents a block or square, around which are laid the service conductors 3, 4. Conductor 1 leads to 3 at f, upon one side of the block, while 2 leads to 4 at 4, upon the opposite side of the block. The greater portion of any fall of electro-motive force will occur in conductors 1, 2, while it will be constant at all points in the service conductors 3, 4, because every point in such conductors is distant from the source by exactly the same mass of conductor, as is evident from inspection of the diagram.

In Figure 19 two blocks B are shown, conductor 1 leading to and connecting with 3 of block B; while 2 leads to and connects with 4 of B, B; while cross conductors 5, 6 connect with the conductors of the blocks. In Figure 20 four blocks are shown, conductor 2 being connected to 4 of the right hand blocks through a branch 9 leading to both right hand blocks, while 1 connects directly to both left hand blocks. In this Figure is shown a house circuit a, a, containing lamps, indicated by circles placed between a, a. In Figure 21 two blocks are connected as in Fig. 19, while from the cross conductors 5, 6, leads a derived circuit 7, 8, leading to two other blocks arranged as described. Instead of two blocks, as in Fig. 19, any number may be used. In all these plans each block and each house circuit are electrically equidistant from the source, by which uniformity and equality therein is attained, the loss or drop of force occurring in the feeding circuits.

What is claimed is,—

First. The method of equalizing the pressure or electro motive force throughout

an electric distributive and translation system, consisting in using feeding circuits which connect to and feed into circuits on which are arranged the translating devices, substantially as set forth.

Second. The combination with a circuit containing translating devices of a a feeding circuit leading thereto from the source of energy and containing no translating devices, substantially as set forth.

Third. The combination in one system of a main circuit connected directly to a source of energy and containing translating devices, and provided with means for lessening its force or pressure to that of the average of the system, a circuit not directly connected to the source of energy containing translating devices, and a feeding circuit connecting the latter circuit with the source of energy, substantially as set forth.

Fourth. The method of equalizing the pressure or electro motive force in the lamp or translating circuits, by connecting the same to the source of energy by feeding circuits in which occur the greater percentage of fall of force, substantially as set forth.

Fifth. The combination of a number of insulated wires of different lengths grouped together and fastened at intervals, forming a gradually tapering conductor, substantially as set forth.

Sixth. The combination with one derived circuit of two branch circuits for different classes of translating devices, each containing a meter and a feeding circuit, substantially as set forth.

Seventh. The combination with one lamp circuit of a series of feeding circuits, substantially as set forth.

Eighth. The combination with one side of an entire metallic circuit of a series of ground connections as auxiliary thereto, whereby a lesser conductor may be used in such half, substantially as set forth.

Ninth. The method of laying the conductors in an electrical supply system, consisting in laying them in sets concentrically as explained, each set being connected to the central station at several points, substantially as set forth.

Tenth. The method of laying the conductors in an electrical supply system, consisting in laying them in sets concentrically as explained, each set being connected to the central station by several sets of branch conductors, and the various sets being connected to each other by several sets of coupler conductors, substantially as set forth.

Eleventh. As an improvement in the art of distributing electricity for use as a lighting and motive power agent, the method of laying the conductors, consisting in laying around each block the service conductors, and uniting the same to the source of electricity by feeding conductors arranged as set forth, all substantially as herein shown and described.

Twelfth. As an improvement in the art of distributing electricity for use as a lighting and motive power agent, the system of conductors set forth, consisting of service conductors laid around each block, feeding conductors connecting them to the source of electricity and united to them at the points designated, and cross conductors connecting the service conductors of a series of blocks, substantially as set forth.

In witness whereof, I, the said Peter Jensen, have hereunto set my hand and seal, this Twentysecond day of March, in the year of our Lord One thousand eight hundred and eighty one.

PETER JENSEN. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode, Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1881.

A.D.1880. Sep. 24. N° 3880.
JENSEN'S SPECIFICATION.

(2 SHEETS)
SHEET 1.

FIG. 8.

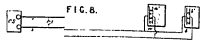


FIG. 9.

FIG. 10.

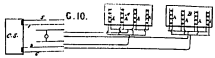


FIG. 11.

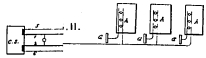


FIG. 12.

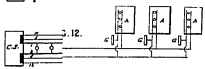


FIG. 13.

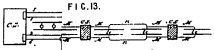


FIG. 14.

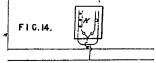
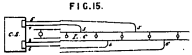


FIG. 15.



A.D. 1880, Sep. 24. No. 3880.
JENSEN'S SPECIFICATION.

(2 SHEETS)
SHEET 1.

FIG. 1.

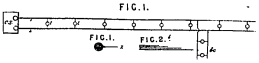
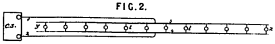


FIG. 2.



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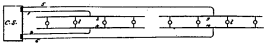

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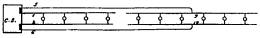


FIG. 5.

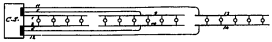
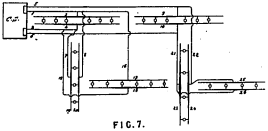


FIG. 6.



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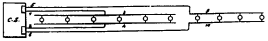


FIG. 8.

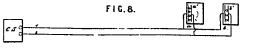


FIG. 9.

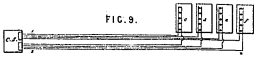


FIG. 10.

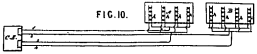


FIG. 11.

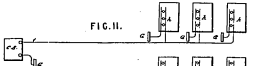
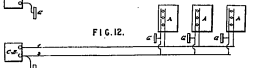


FIG. 12.



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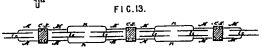


FIG. 14.

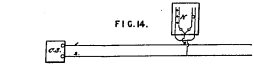
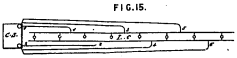


FIG. 15.



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LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1881

A.D.1880, Sep. 24. № 3880.
JENSEN'S SPECIFICATION.

(2 SHEETS.)
SHEET 2.

FIG. 16.

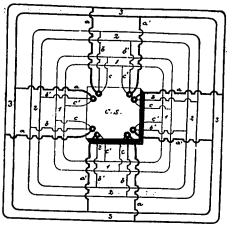


FIG. 17.

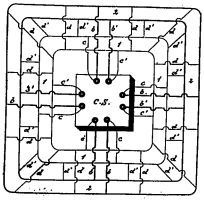


FIG. 18.

FIG. 19.

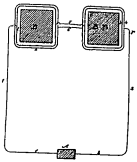


FIG. 21.

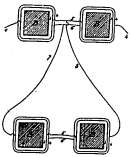
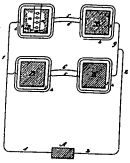


FIG. 20.



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LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
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A.D. 1880, 25th *September*. N° 3894.

Electro-magnetic Railroads, &c.

LETTERS PATENT to Peter Jensen, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN THE CONSTRUCTION OF MACHINERY AND APPLIANCES FOR ELECTRO-MAGNETIC RAILROADS, AND IN THE GENERATION, DISTRIBUTION, AND TRANSLATION OF ELECTRICITY FOR WORKING THE SAME." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Peter Jensen at the Office of the Commissioners of Patents on the 25th September 1880.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN THE CONSTRUCTION OF MACHINERY AND APPLIANCES FOR ELECTRO-MAGNETIC RAILROADS, AND IN THE GENERATION, DISTRIBUTION, AND TRANSLATION OF ELECTRICITY FOR WORKING THE SAME." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

The object of this Invention is to furnish an economical and reliable system of electro magnetic railways or tramways, which while useful in any locality shall be particularly adapted in regions where the traffic is too light for ordinary steam railways, or where the main bulk of the traffic is limited to certain seasons, or where the difficulties or expense of grading render ordinary steam roads impracticable.

To this end the Invention consists in a complete electro magnetic railway system embracing the generation, distribution, and utilization of electric currents as a motive power, and in the novel device and combination of devices therefore, as more particularly hereinafter described and claimed.

In carrying this Invention into effect the rails of the track are electrically connected, so that each line of rails forms one half of a circuit. The road is divided into sections, where from its length this is desirable, each section forming substan-

tially a small independent railroad. For each section a central station is provided at which is located any suitable motor for giving motion to one or more magnets or dynamo electric machines connected thereto.

At each central station, and also at other points where necessary, a portion of a section is electrically cut off from the remainder, which in connection with a siding there laid enables trains to pass each other. Movable switches or shunts are formed in the ends of the main track adjacent to the sidings. The switches are operated by mechanism set in motion by electro magnetic motors having connection to the central station. From each end of each rail section connections are made to series of electrical switches at the central station, by which means the engineer there in charge is enabled to put the current off or on, or reverse the same or any particular track or switch section, and to operate any particular switch.

For the travelling motor or locomotive an electro magnetic engine is mounted upon a suitable frame supported upon the axles of the driving and other wheels. In order that the circuit from one line of rails to the other be not directly through the wheels and axles, but be through the motor, each car is, so to speak, electrically cut in two by the interposition of insulating material somewhere in its structure, the poles of the motor being connected one to each division. A seemingly preferable method is to form the hub and flange of a wheel of separate metallic parts, uniting them by bolting each to a wooden web, which insulates the two, whereby the body of the car and the axles are insulated from the track.

Contact springs bear against the flanges, or preferably against hubs secured thereto by cross bars or "spiders," whose outer ends are bolted to the flanges. These contact springs are connected to the commutator springs of the motor, one to each respectively, through the reverser and governor, controlled contacts hereinafter spoken of.

As in a central system the motive power is constant, irrespective of the conditions of the trains, it seems requisite that the motive power should be connected directly and inflexibly to the driving wheels, but in some such manner as will enable the force to be gradually applied to or withdrawn therefrom.

Therefore a friction wheel is mounted upon a shaft of the motor, and one upon the main driving axle, the two being disconnected, so that motion is not communicated from one to the other. In a swinging frame pivotted at one end, and provided at the other end with a handle, is mounted another or connecting friction wheel, which on depression shall take upon both the friction wheels before named, and transfer the force from one to the other; of course the amount of this transferring is dependent upon the perfection of the frictional bearing of the intermediate upon the other two friction wheels, and may be varied between the limits of the minimum and maximum frictional contact.

To accomplish the same result a motor pulley and a driving pulley may be connected by a loose belt to be tightened by a swinging pulley belt tightener, or the same result may be accomplished in several other known ways.

As the motive power sufficient to move a load upon a bevil with great speed is totally inadequate to move it with the same speed up an incline, and often fails to move the load at all, means (extra amount of steam generative capacity for example) are generally used for furnishing a large excess of power over the amount usually required, adding largely to the dead weight to be carried. In this system however it is proposed to use at all times for a load or train only the amount of power normally required under favorable conditions, providing means by which speed is automatically exchanged for power when necessarily, this to be accomplished by a governor, which upon speed falling upon reaching an incline shall automatically operate to alter the leverage either of belts, friction gear, or clutches, through which the motor acts upon the driving wheel.

As the devices for this purpose are applicable to other than electro motor systems they are not further herein described, but will form the subject matter of a separate application for a Patent.

Upon each engine is located a reversing key through which the circuit passes to the motor, which may be used as a brake in case of emergency, the reversing of the current acting to reverse the direction of the motor, and thereby more rapidly stop it. The operative lever of this reverser is so combined with a spring that it may be held in a central position without any of its contacts infringing on other contacts, and so act also as mere circuit closer or breaker. A centrifugal governor driven from the driving axle is used connected to a series of contacts so as to break the circuit at a number of points simultaneously upon a certain predetermined speed being reached.

Provision is made to dispense with the necessity of much grading, enabling the engine to ascend ordinarily impracticable grades, as follows:—

Upon one or both sides of the engine car a wheel having a grooved face adapted to clasp the head of the rail is mounted in a bearing so combined with a screw or other lifting device that it may be depressed into or elevated from contact with the rail. Upon its axle is fixed a rag or sprocket wheel.

Upon the main driving axle is loosely mounted a friction wheel having attached to it a rag or sprocket pinion. To this loose wheel when necessary motion is communicated from a friction wheel on the motor shaft through an intermediate friction wheel mounted in a swinging frame, as before described. A sprocket chain connects the sprocket wheel on the axle of the grooved wheel and the sprocket pinion. Under ordinary circumstances this friction wheel in the main axle has no motion communicated to it, and the grooved wheel is not in contact with the track; when necessary the grooved wheel is depressed and the intermediate friction wheel so applied as to cause the loose wheel on the main driving axle with its rag or sprocket pinion to be rotated, the motion being communicated to the grooved wheel, which grasping and biting upon the rail head pulls the load up without danger of slipping.

Where the rails are used as conductors of an electrical circuit there is always more or less surface conduction, the amount depending largely upon the dampness or dryness of the adjacent soil ties, and such like.

This surface conduction may be largely reduced, or prevented entirely, in the following manner:—

Between the rail and the tie is placed a piece of felt, paper mache, or other flexible insulating material, preferably so treated as to make it water proof, which piece extends upward on the web on both sides of the rail to the head, forming an insulating shoe.

Between it and the spike is placed a piece of metal of the general configuration of the foot of the rail, upon which the head of the spike takes and bears, so that the insulating material is protected from abrasion or damage by the spike.

Instead of this metal piece a much heavier piece of wood may be used, forming a shoe fastened down by the spike and in turn securing the rail.

The foot and web of the rails are covered with some elastic insulating composition; for example, a rubber paint of which the base is pure linseed oil, the ties, for a space of, say, one half foot to a foot, on each side of the rails being similarly painted.

In using electro motors the best results are obtained when the speed of the rotating armature is maintained uniform and at a very high rate.

In railway motors a large excess of power over that required for a given speed upon the level is provided, in order that even a very much diminished speed may be maintained upon an up grade, the speed of the motor being diminished proportionately.

One object of this Invention is to so arrange a motor in relation to the driven mechanism that the speed of the motor shall always remain unchanged, not being affected by changes in the speed of the driven mechanism, and that power may be exchanged for speed, or *vice versa*, as circumstances may demand, without the speed of the motor being affected. Another object is to furnish a method of pro-

pulsion of trains analogous to the action of a quadruped in drawing a load, especially applicable as means for climbing a grade or assisting therein.

To accomplish these objects a thread is mounted upon the shaft of the rotating armature meshing into a worm upon a shaft, at whose opposite end is a bevil gear taking into a bevil gear upon a shaft parallel to the shaft of the engine.

Upon this latter shaft are two gear wheels, one having several times as many teeth as the other, both being loosely mounted upon a shaft, on which and between the two gears is fixed a suitable clutch in order that one or the other may be caused to rotate with the axle upon the clutch being thrown to the extreme limit of its motion, but that when the clutch is in an intermediate position neither shall be locked into the shaft. In order to prevent the clutch being moved too rapidly it may be operated by a screw threaded lever passing through the free end of the lever.

Upon the main driven axle two gear wheels are rigidly fixed, one large and one small, the larger one gearing with the smaller one loose upon the shaft last noted, while the smaller one gears with the larger one loose upon such shaft.

It is evident then that whether speed be converted into power or power into speed will depend on whether motion be communicated from the shaft driven from the armature shaft to the main driven axle through the smaller or through the larger gear thereon.

For use upon grades a device which may be called a creeper is used somewhat as follows:—

Upon the front of the engine is mounted a vertical shaft carrying a worm gearing into the thread upon the armature shaft.

This vertical shaft is mounted in adjustable bearings, so that the worm may be thrown into or out of gear with the thread, as desired.

Upon the lower end of the vertical shaft is a bevil gear meshing into a bevil gear upon a horizontal shaft, to whose ends by crank arms or pins are attached rods, each carrying at its opposite end a box or casing provided with a central wheel which rides upon the rail. In the box or casing, so as to take upon the sides of the rail, are eccentrically pivoted two wheels, one on each side. These side wheels being eccentrically pivoted allow the box to be pushed forward along the side of the rail, but prevent retrograde motion by closing together and grasping the rail. The arms carrying the grippers or creepers are mounted so that they may be let down upon or removed from the track as occasion requires; hence as a rod is reciprocated from the motor through the gearing described it pushes forward during one half revolution the box or casing which slides upon the rail; upon the commencement of the other half of the revolution by the action of the eccentrically pivoted wheels or rollers the box or casing is locked to the rail and the engine is pulled up.

One only being used the action would be a series of pulls and pauses, and if desired one only may be used, taking upon either rail or upon a central rail laid especially for this purpose.

In practice however it is desirable to use at least two, one for each rail, with cranks so arranged relatively to each other that while one is being slid forward the other is holding, so that a continuous motion may be produced. Additional grippers or creepers may also be placed at the rear of the train, so that a continuous pulling and pushing action is produced.

Instead of rollers within the box or casing referred to another form of device may be used, in order to give a larger gripping surface.

Within the box or casing are two bars parallel to the rail, one on each side. These bars are attached to the casing or box by loose toggle joints in such way that upon motion forward of the box or casing the bars recede from the rail, but upon retrograde movement they approach and grip the rail.

Another object of this Invention is to produce a simple and effective electro-

magnetic brake adapted for use on any style of rail road vehicle, but more especially intended and adapted for use in the system herein described.

It consists in placing an electro-magnet in such relation to some rotating metallic portion of the running gear of the vehicle to be stopped that the magnetic circuit shall be through such rotating metallic portion, the electro-magnet being furnished with mobile heads, which may move towards and clasp the rotating portion whenever the circuit of the magnet is closed.

Upon the axle and at or near its centre is rigidly fixed a disc of iron, which rotates with the axle and between the polar extremities of an electro-magnet, suitably fastened to or supported from the bottom of the car.

The cores of this electro-magnet are extended beyond the coils, forming a spindle, which is reduced in size when necessary, the ends being screw threaded to receive nuts.

Upon each spindle is placed a block of iron or other magnetic metal, forming a polar extension secured in place by a nut.

The orifices in the blocks into which the spindles pass are elongated, so that the blocks or polar extensions may have a movement to or from the fixed disc upon the axle rotating between them.

The polar extensions are normally held away from the disc by suitable springs of low resistance.

When is is desired to use the brake a circuit from any suitable source of electricity is closed through the coils of the electro-magnets, whereupon the polar extensions mutually attract the disc. It however being fixed while they are movable the attractive force causes them to move to the disc and grasp it between them, causing a retardation or stoppage of its rotation, and so acting through it as effective brake upon the wheels. Upon breakage of the circuit the springs restore the polar extensions to their normal position.

When desired, for the purpose of throwing the brakes off instantly, a momentary reverse current may be thrown into the circuit just after breaking, causing a momentary but instantaneous repulsion from the disc, and assisting the springs in removing the polar extensions. It is evident that instead of one, several sets of such brakes may be applied to each axle when desired.

In this system of electro-magnetic railways where the tracks themselves are used as the conductors, it is desirable to make some provision, guarding against cessation of effect of the current at crossings, switches, frogs, and such like, or other places where it may be desirable to cut out a portion of the track from the circuit.

This may be accomplished by connecting the ends of the tracks in circuit adjacent to the opposite ends of the cut out section by wire or other conductors, so that a circuit is formed around such cut out portion.

As the greatest length of any section necessary to be cut out will never exceed the average length of a train, or even the length of the shortest train, it is preferred to accomplish the result in the following manner:—

As before described, wheels having their flanges and hubs insulated from each other are used, commutator brushes being used to take the current from hubs electrically connected to the flanges, such commutator brushes being used only with the wheels of the engine.

It is now proposed to use such commutator brushes with the wheels of several of the cars of the train, one of which car should always be the last one in the train.

All the commutator brushes used on either side of the train are connected by a conductor to the appropriate commutator on the engine, and the conductors are so arranged on the cars that they may be readily connected.

By this arrangement the cut out section is electrically bridged over on the train itself, instead of by wires attached directly to the portions of the track in circuit.

Upon roads already built and equipped for steam transport, but where it is desirable to use this system of locomotion, it may be preferable to make the change from one system to the other gradually.

To admit of gradual change, arrangements must be made permitting the use of both systems.

To do this, a third or central rail or conductor is used, electrically connected in stations of suitable length, and thoroughly insulated from the bed. To the cars are attached arms carrying rollers or auxiliary wheels, taking upon the third rail and conveying the current therefrom through the motor upon the train, the ordinary rails being used as the return circuit.

In order to most thoroughly insulate the third or centre rail it may be placed at the ties in a chair of glass or other insulating material, only morticed into the tie or laid on the tie and spiked thereto, or an insulating shield of glass may be interposed between the rail and a metallic chair.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Peter Jensen in the Great Seal Patent Office on the 25th March 1881.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN THE CONSTRUCTION OF MACHINERY AND APPLIANCES FOR ELECTRO-MAGNETIC RAIL-ROADS, AND IN THE GENERATION, DISTRIBUTION, AND TRANSLATION OF ELECTRICITY FOR WORKING THE SAME." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

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To this end the Invention consists in a complete electro magnetic railway system embracing the generation, distribution, and utilization of electric currents as a motive power, and in the novel devices and combinations of devices therefor, as more particularly hereinafter described and claimed.

In carrying this Invention into effect the rails of the track are electrically connected, so that each line of rails forms one half of a circuit. The road is divided into sections, where from its length this is desirable, each section forming substantially a small independent railroad. For each section a central station is provided, at which is located any suitable motor for giving motion to one or more magneto or dynamo electric machines connected thereto. At each central station, and also at other points where necessary, a portion of a section is electrically cut off from the remainder, which portion being connected with a siding there laid enables trains to pass each other. Movable switches or shunts are formed in the ends of the main track adjacent to the sidings. The switches are operated by mechanism set in motion by electro magnetic motors having connection to the central section. From each end of each rail section connections are made to series of electrical switches at the central station, by which means the engineer there in charge is enabled to put the current off or on, or reverse the same on any particular track or switch section, and to operate any particular switch.

For the travelling motor or locomotive, an electrom-agnetic engine is mounted upon a suitable frame, supported upon the axles of the driving and other wheels. In order that the circuit from one line of rails to the other be not directly through the wheels and axles, but be through the motor, each car is, so to speak, electrically cut in two by the interposition of insulating material somewhere in its structure, the poles of the motor being connected one to each division. A seemingly preferable method is to form the hub and flange of a wheel of separate metallic parts, uniting them by bolting each to a wooden web which insulates the two, whereby the body of the car and the axles are insulated from the track.

Contact springs bear against the flanges, or preferably against hubs secured thereto by cross bars or "spiders" whose outer ends are bolted to the flanges.

These contact springs are connected to the commutator springs of the motor, one to each, respectively through the reverser and governor controlled contacts hereinafter spoken of.

As in a central system the motive power is constant, irrespective of the conditions of the trains, it seems requisite that the motive power should be connected directly and inflexibly to the driving wheels, but in some such manner as to enable the

force to be gradually applied to or withdrawn therefrom. Therefore a friction wheel is mounted upon the shaft of the motor, and one upon the main driving axle, the two being disconnected, so that motion is not communicated from one to the other. In a swinging frame pivoted at one end and provided at the other end with a handle, is mounted another or connecting friction wheel, which on depression shall take upon both the friction wheels before named, and transfer the force from one to the other. Of course the amount of this transferring is dependent upon the perfection of the frictional bearing of the intermediate upon the other two friction wheels, and may be varied between the limits of the minimum and maximum frictional contact.

To accomplish the same result a motor pulley and a driving pulley may be connected by a loose belt to be tightened by a swinging pulley belt tightener, or the same result may be accomplished in several other ways.

As the motive power sufficient to move a load upon a level with great speed is totally inadequate to move it with the same speed upon incline, and often fails to move the load at all, means (extra amount of steam generative capacity, etc.) are generally used for furnishing a large excess of power over the amount usually required, adding largely to the dead weight to be carried. In this system however it is proposed to use at all times for a load or train only the amount of power normally required under favorable conditions, providing means by which speed is automatically exchanged for power when necessary; this is to be accomplished by a governor, which, upon speed falling upon reaching an incline, shall automatically operate to alter the leverage either of belts, friction gear, or clutches, through which the motor acts upon the driving wheel. As the devices for this purpose are applicable to other than electro motor systems they are not further herein described or illustrated, but will form the subject matter of a separate application for a Patent.

Upon each engine is located a reversing key through which the circuit passes to the motor, which may be used as a brake in case of emergency, the reversing of the current acting to reverse the direction of the motor, and therefore more rapidly stop it.

The operative lever of this reverser is so combined with a spring that it may be held in a central position without any of its contacts impinging on other contacts, and so act also as a mere circuit closer or breaker. A centrifugal governor driven from the driving axle is used, connected to a series of contacts, as fully explained in a prior application, so as to break the circuit at a number of points simultaneously upon a certain pre-determined speed being reached.

Provision is made to dispense with the necessity of much grading, enabling the engine to ascend ordinarily impracticable grades as follows:—Upon one or both sides of the engine car a wheel having a grooved face adapted to clasp the head of the rail is mounted in a bearing so combined with a screw or other lifting device that it may be depressed into or elevated from contact with the rail. Upon its axle is fixed a rag or sprocket wheel. Upon the main driving axle is loosely mounted a friction wheel having attached to it a rag or sprocket pinion. To this loose wheel, when necessary, motion is communicated from a friction wheel on the motor shaft through an intermediate friction wheel mounted in a swinging frame, as before described; a sprocket chain connects the sprocket wheel in the axle of the grooved wheel and the sprocket pinion. Under ordinary circumstances this friction wheel in the main axle has no motion communicated to it, and the grooved wheel is not in contact with the track.

When necessary the grooved wheel is depressed and the intermediate friction wheel so applied as to cause the loose wheel on the main driving axle with its rag or sprocket pinion to be rotated, the motion being communicated to the grooved wheel, wich grasping and biting upon the rail head pulls the load up without danger of slipping.

In Figures 1 to 15 of the accompanying Drawings is shown more in detail how this portion of the Invention may be carried into effect; it is to be remembered

however, that these details may be varied or equivalents used, and that therefore the Invention is not limited generally in such cases to the precise details therein illustrated.

In these Drawings:—Fig. 1 is a view showing the general arrangement of a central station and the track connections.

Fig. 2, a portion of the frame of a car.

Fig. 3, a perspective of an engine car.

Fig. 4, a perspective view of the rail gripping devices for ascending grades, with a section of the grooved wheel and rail.

Fig. 5, a perspective of the reverser, governor, and multiple circuit breaker.

Fig. 6, a bottom view of the reverser.

Figs. 7 & 8 are views of different mechanical means for operating the track switches.

Fig. 9 is a perspective view of the electrical switches at central stations.

Fig. 10 is a perspective view showing means of electrically connecting the rails.

Figs. 11 & 12 are sectional views showing differents ways of electrically dividing the car, so as to insulate one flange from the other.

Fig. 13 is a diagram showing several sections and a side road or feeder.

Fig. 14 is a diagram showing connections when desired at a bridge or other short section.

Fig. 15 is a diagram showing the method of connecting the electrical devices in multiple arc.

A is a central station, at which are located a steam boiler and engine as shown, although the motor may be a water or any other suitable form of motor; B is any suitable magneto or dynamo electric machine, connected with and operated by the motor engine. From the generator connections 1 and 2 are made to the switches 3 and 4, one series being connected to one commutator, the other series to the other commutator.

M T, M T^1, M T^{11}, are the main line of track. The rails of each line of rails are electrically connected by means of copper wires or strips E (Fig. 10) under the fish plate E, P, and held thereby against the ends of two adjacent rails. A portion M T, of sufficient length to accomodate one or more trains is electrically separated from the remainder of the section M T^1, and M T^{11}. At the side thereof and of the same length is the siding S W. The parts of M T^1, and M T^{11}, adjacent to the ends of M T, are made movable so as to constitute switches by which trains may be switched or shunted from M T^1, or M T^{11}, to M T, or S W, *or vice versa.* For each track switch is arranged an electro motor S M; a circuit 5, 5, leading from one series of switches 3, through both switch motors to the other series of switches 4. From 5 a connection 6 is made to one of the series of switches in order that when desired one alone of the switch motors may be used.

By this means trains are enabled to pass each other at a station, for instance, two trains have arrived at the station, one motor alone is operated, and a train, say, from M T^1, is run on to M T; the other motor is then operated, and a train passes from M T^{11} on to S W, thence to M T^1, while the first train is passed from M T to M T^{11}.

The switch motors are geared to the switch lever S L, so that when the circuit is closed through a switch motor, its motion is communicated to the switch. In Fig. 7 is shown one means of so communicating motion to the switch, in which S L is the switch lever connected to a double rack in which works a wheel toothed for some-what less than half its periphery, which connects by a crank rod C, R, either directly or through intermediate gearing, with the shaft of the switch motor.

Fig. 8 shows another way in which the switch lever S L is connected to a frame D, sliding in suitable ways. In this works a cam d whose shaft carries a gear, into which takes a pinion on the shaft of the switch motor. The gear and pinion being well known are not shown; when so needed these switches may be located at a distance from the central station and operated automatically by the train instead of by the engineer at the central station; in such cases a circuit is led to and some distance beyond the switch to be operated, containing at the switch a

switch motor, moving the switch in one direction; the reverse movement being by a spring. At a little distance on each side of the switch engine are located circuit closers, arranged to be hit by an arm projecting from the train. If a train be started, which it is intended shall go off upon a switch or branch, the arm on the train is set. On coming to the first circuit closer, the arm strikes it, closing circuit, moving and holding the switch. The train passes on to the switch, strikes the second circuit closer, opening it; the circuit being now broken, the spring restores the switch. Where there are several switches a permutation arrangement driven from the running gear of the train will be upon the train, capable of being set so that it shall project or lower the arm for operating the circuit closers only as it approaches the proper switch.

In Fig. 9 is shown in detail the switches used in the series 3, 4. Levers a, a, a, are pivoted in suitable supports upon the base G; springs a^3, a^{11}, pulling the lever to the rear. Upon the base are located springs b, b, with their inner ends turned up so as to form a catch for the lower ends of the levers, as shown. From the springs b, b, of the electrical switch, series 3, 4, are made to each line of rails of each track section and track switch, and also to the switch motors, for instance, from M T¹, wires 7, 7, lead one to 3 and one to 4. 8, 8, lead in same way from one end of M T, while 11, 11, lead from the other end. In same way 9, 9, and 10, 10, connect 3 and 4 and S W. By simply throwing the proper switches so that they catch on their respective springs the circuit is closed to any desired section, and the current thrown therethrough.

The circuit through any particular section being closed, and it forming the conductors for the current, a circuit is formed from one line of rails to the other, and the current utilized as a motive agent by an engine constructed as shown in Fig. 3, in which F is any suitable frame work suspended from the main driving axle and placed upon the other axle.

The wheels used under the engine car and all other cars are constructed as shown in Fig. 11, in which the flanges F l, are made separately, and connected by a wooden web o, to which they are bolted, the wheel then consisting of a metallic hub, a metallic flange, and an intervening wooden or insulating web. By this means the axles and body of the car are insulated from the flanges and track, and the current cannot pass therethrough from one rail to the other. Although both wheels in Fig. 11 are shown as of this construction, it is evident that these on one side of a car only need be so constructed as thereby the formation of a circuit direct from one line of rails to the other, would be prevented. The same purpose may be subserved by the construction shown in Fig. 12, in which ordinary wheels are used, the axle being cut in two and united by a sleeve Q, insulated therefrom by P, and bolts insulated from, but passing through the halves of the axles.

On the engine car a spider or frame N, (Figures 3 and 11) is secured to the flange F l, so as to be in electrical contact therewith, but not touching or forming contact with the hub M. Upon the center of N is a boss or spindle n on which bears a commutator brush held by arm p. The current then passes from one line of rails through one flange F l, frame N, boss or spindle n, commutator p to the reversing key (Fig. 5) the contact points 13, 14, 15, 16, to the electric engine, thence by the other arm p, spindle, frame, and flange to the other line of rails.

The reversing key is shown in Figs. 5 and 6, in which U and V are elbow levers, pivoted at Q and Q¹ respectively, the springs s and s^1 tending to cause them to close circuit normally in r and r^1; V is connected to P¹, and U to P¹¹; r and r^1 are connected to the series of spring contacts, and then to one pole of the motor engine. Between the levers U and V is placed the operating lever T, pivoted at o, and connected to the other pole of the motor engine. Upon the under side of T is a pin z taking into a slot y in a cam plate w pivoted at x. The cam plate w is moved as the lever T is moved by the action of the pin z in the slot y. It is of such a breadth, that when standing in a neutral or untilted position, its opposite sides shall take against pins u, v, on levers U, V, and force them from their contacts, leaving the circuit open. A movement to either side however allows one

of the levers U V, to make contact with r or r^1, the other being kept from contact therewith by its contact with lever T. Upon the engine is mounted a centrifugal governor O r, driven from the main driving axle of the car. The lower end of the rod, which is reciprocated by the governor balls, takes upon a lever 17, pivoted at 18, whose outer end takes under a series of contact springs 13, 14, 15, 16, placed in the circuit. The governor is adjusted to break the circuit whenever a predetermined rate of speed is reached, breaking it in a number of places simultaneously so as to greatly reduce, if not practically eliminate, the spark due to the breaking of the circuit of a large current.

The circuit being now completed through the motor and it being in operation motion is communicated to the main driving axle as follows, reference being had to Fig 3, in which g is the main driving axle upon which is mounted a friction wheel G. Upon the shaft e of the magnetic engine is a friction pulley c, the pulleys e and G not being in contact. In a swinging frame f pivoted at h is mounted a friction pulley i. The frame f being depressed bears upon e and G, and communicates motion from e to G, the percentage transferred being proportional to the frictional contact of i upon e and G. As giving a better traction to avoid slipping on grades a device shown in Fig. 3 or the device shown in Fig. 4 may be used singly or together. In Fig. 3, E M is a pair of ordinary electro magnets, there being one or more pairs on each side. These magnets are suspended from the frame so that their poles are over, and in immediate contiguity to the rails. From them a circuit extends to the arm p so that they are in a multiple circuit to the track. In their circuit is placed a key which may be operated by hand or which may be operated by the governor automatically under the arrangement hereinbefore mentioned. Upon coming to a grade the circuit is closed and the magnets immediately exert their attractive influence upon the track, tending to hold the car firmly and to prevent its slipping.

In Fig. 4, in addition to to the devices already described as mounted upon shaft e and axle g, H is a friction pulley loosely mounted upon the main driving axle g; wheel π, and in a frame similar to frame f is mounted the friction wheel l; upon depressing the frame motion is communicated from π to H and I, which rotate upon the shaft g. A wheel L having a grooved face is secured to an axle which is mounted in a box adjustably secured to the frame by a screw S. A sprocket chain m connects I and K. Upon reaching a grade by turning the screw S the wheel L is depressed and grips the rail, as shown, motion being communicated thereto, as before described, by which arrangement the engine can climb a grade impracticable in common steam rail road.

It should be stated thall all the devices using current are arranged upon the mutiple arc system, the rails forming the main conductors and all the electrical devices being in derived circuits thereto. This is diagrammatically shown in devices being in derived circuits thereto. This is diagrammatically shown in Fig. 15, in which R A, is the rotating armature; F M, the field magnets; E M, the electro magnets for increasing traction on track; and L p, an electric lamp for lighting the car or for a head light. As here represented each is connected in a derived circuit from the line of rails of the track M T. In practice however the current from the main station, the divisions and side road being connected to the generator at the central station on the multiple arc system.

In Fig. 14, B g represents a short section of track on a bridge, or in any other locality where it is desired to slow up. This section is insulated from its neighbors, but connected thereto by wire conductors as shown at b^1, b^{11}, so that upon such

section the current is reversed slowing the motor, the current being again reversed at the other end of the bridge section restoring the speed.

In lieu of this arrangement very short sections may be disconnected entirely electrically, connection being made between the sections adjacent to the cut out section by wires passing around such section, so that the motive power is withdrawn entirely on such sections.

At the central station it is advisable to place an electrometer in circuit, as the deflection of its needle gives a good indication of the relative position of a train upon a section. As at times it may be necessary to keep the track clean, free from snow, or other impediments to a good contact between the flange and track, it is preferable to mount in front of the engines brushes rotating at right angles to the rails, and driven by a small motor on the engine car specially set aside for the work.

In using electro motors, the best results are attained when the speed of the rotating armature is maintained uniform and at a very high rate.

In railway motors a large excess of power over that required for a given speed upon a level is provided in order that even a very much diminished speed may be maintained upon an up grade, the speed of the motor being diminished proportionately.

One object of this Invention is to so arrange a motor in relation to the driven mechanism, that the speed of the motor shall always remain unchanged, not being affected by changes in the speed of the driven mechanism, and that power may be exchanged for speed, or vice versa, as circumstances may demand, without the speed of the motor being affected. Another object is to furnish a method of propulsion of trains analogous to the action of a quadruped in drawing a load, especially applicable as means for climbing a grade, or assisting therein.

To accomplish these objects a thread is mounted upon the shaft of the rotating armature meshing into a worm upon a shaft, at whose opposite end is a bevel gear taking into a bevel gear upon a shaft, parallel to the shaft of the engine.

Upon this latter shaft are two gear wheels, one having several times as many teeth as the other, both being loosely mounted upon the shaft, on which and between the two gears is fixed a suitable clutch, in order that one or the other may be caused to rotate with the axle upon the clutch, being thrown to or near to the extreme limit of its motion, but that when the clutch is in an intermediate position, neither shall be locked into the shaft. In order to prevent the clutch being moved too rapidly, it may be operated by a screw threaded lever passing through the free end of the lever.

Upon the main driven axle two gear wheels are rigidly fixed, one large and one small, the larger one gearing with the smaller one loose upon the shaft last noted, while the smaller one gears with the larger one loose upon such shaft.

It is evident then that whether speed be converted into power, or power into speed, will depend on whether motion be communicated from the shaft driven from the armature shaft to the main driven axle, through the smaller or through the larger gear thereon.

For use upon grades a device, which may be called a creeper, is used somewhat as follows:—

Upon the front of the engine is mounted a vertical shaft carrying a worm, gearing into the thread, upon the armature shaft. This vertical shaft is mounted in adjustable bearings, so that the worm may be thrown into or out of gear with the thread, as desired. Upon the lower end of the vertical shaft is a bevel gear meshing into a bevel gear upon a horizontal shaft, to whose ends by crank arms or pins are attached rods, each carrying at its opposite end a box or casing provided with a central wheel which rides upon the rail. In the box or casing, so as to take upon the sides of the rail, are eccentrically pivoted two wheels, one on each side. These side wheels being eccentrically pivoted, allow the box to be pushed forward along the side of the rail, but prevent retrograde motion by closing together and grasping

the rail. The arms carrying the grippers or creepers are mounted so that they may be let down upon or removed from the track, as occasion requires. Hence as a rod is reciprocated from the motor through the gearing described, it pushes forward through one half revolution the box or casing which slides upon the rail. Upon the commencement of the other half of the revolution, by the action of the eccentrically pivoted wheels or rollers, the box or casing is locked to the rail, and the engine is pulled up.

One only being used, the action would be a series of pulls and pauses, and if desired, one only may be used, taking upon either rail, or upon a central rail laid especially for this purpose.

In practice however it is desirable to use at least two, one for each rail, with cranks so arranged relatively to each other, that while one is being slid forward, the other is holding, so that a continuous motion may be produced. Additional grippers or creepers may also be placed at the rear of the train, so that a continuous pulling and pushing action is produced.

Instead of rollers within the box or casing referred to, another form of device may be used in order to give a larger gripping surface.

Within the box or casing are two bars parallel to the rail, one on each side; these bars are attached to the casing or box by loose toggle joints in such way that upon motion forward of the box or casing the bars recede from the rail; but upon retrograde movement they approach and grip the rail.

The operation of these devices will be better understood by reference to Figs. 15ª, 16, 17, and 18 of the Drawings, in which

Fig. 15ª is a perspective view of an engine, embodying both the motor and the creeper.

Fig. 16 and 17 are details of the creeper.

Fig. 18 is a perspective view of the motor gearing.

A is the rotating armature of the electric motor, mounted on shaft *a*, secured in suitable bearings. Upon the shaft *a* is the worm or screw B, gearing into the worm gear C on shaft *c*, upon whose lower end is the bevel gear D meshing with bevel gear E on shaft *e*, upon which are mounted loosely the gears F, H; H having a much larger number of teeth than F.

Between F and H is mounted so as to rotate with *e* the clutch sleeve C^1, upon which is mounted a suitable clutch, controlled by clutch lever L pivoted at *l*. The preferable clutch is the one known as Mason's clutch. As such clutch is well known it has not been thought necessary to encumber the Drawings with a detailed view of it.

As hereinafter stated, provision is made for the constant rotation of A without imparting motion to F or H. In order then to bring either into operation gradually, avoiding jar or shock, I sometimes pass a screw threaded rod through the free end of L and at right angles thereto, one end of the rod ending in a crank or wheel by which the rod may be turned, each revolution moving the clutch only the width of one screw thread.

The gears F and H mesh into gears G and I on shaft *g*, which is the main driven axle, carrying wheels, not shown, at its extremities.

The gear G bears the same relation to F in number of teeth as H bears to I.

It is desirable that the rate of rotation of *g* should always be much less than that of A. The relation existing between B and C and H and I insures this, the speed of *g* however remaining such as to give a very high, or as high as desirable, rate of progress to the car, the provision being such that only the power required for the maximum rate of speed and load upon a level is furnished, the clutch being thrown so that the motion is communicated to *g* through H and I.

Upon reaching an up grade the clutch is thrown so that motion is communicated through F, G, the speed consequently is diminished by the ratio existing between the two with a corresponding increase of force.

It should be noted that the relation between the clutch and the gears F, H, is such that when the clutch is in a central position no motion is communicated to

either gear, so that when the train may be stopped the motor still rotating at its best effective rate ready for instantaneous work with the delay incident to bringing its speed up from zero to an effective rate.

From this it can readily be seen that the rate of rotation of armature may be kept constant, while the rate of speed of the train may be varied to suit the various requirements of change of grade or load, ensuring full utilization under all conditions of the prime motor force applied.

Upon the front end of the engine car is a shaft *h*, on which is a sleeve supporting the lower end of a shaft *n*, whose upper end is secured in a bearing J which permits of a slight movement of the shaft *n*.

Upon *n* is mounted a worm gear N, which may be made to mesh with the worm or screw B on the armature shaft *u*.

Upon and near the lower end of *n* is the bevel gear O, meshing into a bevel gear P upon shaft *h*, to whose outer ends are attached the arms R by means of cranks Q. The-e arms R are arranged with any simple lifting device, so that they can be let down upon or removed up from the rails.

Pivoted to R is a box or casing S, in whose upper portion is a wheel *u* riding upon the top of the rail.

Within S, and upon each side of the rail, wheels *s* are mounted, eccentrically pivoted as shown, the opening between them at the widest point being just enough more than the width of the rail to permit its passage therethrough. From this it is evident that if a body the width of a rail be slid between them in the direction of the arrow, Fig. 2, it will push them apart, but that if the motion be in the opposite direction it will cause the rollers *s*, *s*, to approach each other, gripping the body between them.

When necessary the worm N is thrown into gear with B, motion being communicated thereby to the arms R. Upon the forward half of the movement the arm R pushes the box S along the rail. Upon the commencement of the latter half of the movement the rollers *s*, *s*, approach each other, gripping the track and locking the box or casing to it, whereupon the car is pulled up toward S.

Where the rails are light and might possibly be injured or indented an alternative device, shown in Fig. 17, may be used, which gives a long grip upon each side of the rail head.

In this Figure 4 is a box or frame, connected pivotally to R, and having the wheel *u*, as in the other form.

Connected to 4 by toggle joints 3, 3, are the gripping bars 1, 2, one on each side. As seen, upon motion of the box or frame in one direction, on account of the toggle used, the bars 1, 2, recede from the rail, but upon motion in the opposite direction approach the rail, gripping it and locking the box or frame thereto.

Springs may be applied to the rollers *s*, *s*, or bars 1, 2, so as to normally hold them to the rail with a light pressure, not sufficient to interfere with their sliding in one direction, but causing them to act instantly upon attempted motion in the opposite direction.

By the use of the creepers described, the effect of great traction may be obtained with little weight, so that the dead weight of engines and cars may be reduced to a minimum.

Another object of this Invention is to produce a simple and effective electro-magnetic brake adapted for use on any style of railroad vehicle, but more especially intended and adapted for use in the system herein described.

It consists in placing an electro magnet in such relation to some rotating metallic portion of the running gear of the vehicle to be stopped, that the magnetic circuit shall be through such rotating metallic portion, the electro magnet being furnished with mobile heads, which may move toward and clasp the rotating portion whenever the circuit of the magnet is closed.

Upon the axle and at or near its centre is rigidly fixed a disc of iron which rotates with the axle and between the polar extremities of an electro magnet suitably fastened to or supported from the bottom of the car.

The cores of the electro magnet are extended beyond the coils, forming a spindle, which is reduced in size when necessary, the ends being screw threaded to receive nuts. Upon each spindle is placed a block of iron or other magnetic metal forming a polar extension secured in place by a nut.

The cores in the blocks into which the spindles pass are elongated so that the blocks or polar extensions may have a movement to or from the fixed disc upon the axle rotating between them. The polar extensions are normally held away from the disc by suitable springs of low resilience.

When it is desired to use the brake, a circuit from any suitable source of electricity is closed through the coils of the electro magnets, whereupon the polar extensions mutually attract the disc. It however being fixed, while they are movable, the attractive force causes them to move to the disc and grasp it between them, causing a retardation or stoppage of its rotation, and so acting through it as an effective brake upon the wheels.

Upon breakage of the circuit the springs restore the polar extensions to their normal position.

When desired, for the purpose of throwing the brakes off instantly, a momentary reverse current may be thrown into the circuit just after breaking, causing a momentary but instantaneous repulsion from the disc, and assisting the springs in removing the polar extensions. It is evident that, instead of one, several sets of such brakes may be applied to each axle when desired.

This brake is illustrated in Figures 19 and 20 of the Drawings, in which Fig. 19 is a perspective view of a portion of the bottom of a car, showing a brake; Fig. 20 shows the polar extension and spindle of the core in detail.

A is the bottom of a car resting upon the framing E, E; B is an axle extending from wheel C to wheel on other side not shown.

Upon this axle is rigidly secured the iron disc F, rotating between the polar extensions *d*, *d*, of electro magnet D suitably secured to the framing E, E.

Each of the cores of the magnet extends beyond the coils, forming a spindle *g* on each core, whose end is screw threaded to receive a nut *h*.

Each polar extension *d* is formed with a elongated slot *e*, so that it may be fitted upon the spindle and be free to move thereon in one direction, viz., to and from the disc F.

A spring *k*, which may be any of the well known forms, is combined with each polar extension, and serves normally to hold it away from the disc.

It is evident that the electro magnet D may be mounted so that the flange, or a portion of the web of the wheel C, shall rotate between *d*, *d*, and they operate directly thereon instead of upon a disc, the vital principle of the Invention being that the magnetic circuit of the electro magnet shall be closed through some moving portion.

In such a system of electro magnetic railways as this, where the tracks themselves are used as the conductors, it is desirable to make some provision guarding against cessation of effect of the current at crossings, switches, frogs, etc., or other places where it may be desirable to cut out a portion of the track from the circuit.

This may be accomplished by connecting the ends of the tracks in circuit adjacent to the opposite ends of the cut out section by wire or other conductors, so that a circuit is formed around such cut out portion.

As the greatest length of any section necessary to be cut out will never exceed the average length of a train, or even the length of the shortest trains, it is preferred to accomplish the result in the following manner:—

As before described, wheels having their hubs and flanges insulated from each other are used, commutator brushes being arranged to take the current from hubs electrically connected to the flanges, such commutator brushes being used only with the wheels of the engine.

It is proposed to use such commutator brushes with the wheels of several cars of a train, one of which cars should always be the last one in the train.

All the commutator brushes used on either side of the train being connected by a conductor to the appropriate commutator on the engine, the conductors being so arranged on the cars that they may be readily connected.

By this arrangement the cut out section is electrically bridged over on the train itself, instead of by wires attached directly to the portions of the track in circuit.

Upon roads already built and equipped for steam transportation; but where it is desirable to use this system of locomotion, it may be preferable to make the change from one system to the other gradually.

To admit of gradual change, arrangements must be made permitting of the use of both systems. To do this a third or central rail or conductor is required, electrically connected in sections of suitable length, and thoroughly insulated from the bed. To the cars are attached arms carrying rollers or auxiliary wheels taking upon the third rail and carrying the current therefrom through the motor upon the train, the ordinary rails being used as the return circuit.

This is illustrated in Figs. 21, 22, and 23, in which

Fig. 21 is a perspective of the running gear of two cars, each provided with means for taking the current from the track, the cars being connected together.

Fig. 22, a perspective showing the third or central rail, and arrangements of circuits on the cars.

Fig. 23, a side view of an engine and car properly arranged, and a cross section of three rails with circuit connections.

In Fig. 21, A and B are two rail sections, B being an electrically connected section, while A is cut out from the circuit at *a*, the section A representing a frog, a switch, or other place where it is necessary or desirable to cut out electrically a part of the track; C, D, is the frame of two cars, C being the engine or motor car, the wheels of which are constructed as before described, that is, with the hub and flange insulated from each other, a frame and hub *b* insulated from the hub of the wheels being connected to the flange or commutator brush *c*, taking upon *b*, and completing circuit to the engine.

Wheels of the same construction are used with the car D, which is the last of the train, any number of cars, all or some of which are similarly constructed, being supposed to intervene between C and D.

Preferably the frame and hub upon ordinary cars is upon the inside of the wheels, as shown at *e* and *f*.

Conductors 1 and 2 run the length of the train, connecting all the commutators, 1 upon one side, and 2 upon the other.

It is apparent, then, that when the engine car has passed upon the cut out section there will be no cessation of action thereon, as the current will pass from the conducting section B, through the wheels and commutators of car D, by conductors 1, 2, to the engine.

In the ordinary electrically connected sections this arrangement has the advantage of making contact with the rails in many places, insuring perfect continuity of circuit, and lessening the spark due to any imperfect contacts consequent upon oxidized spots on the rail.

In Fig. 22, E, E', are the rails of an ordinary railroad which it is desired to gradually change to an electro magnetic system. F is a third rail, laid preferably between the ordinary rails, and laid in chairs which thoroughly insulate it from the ties.

From the one pole of the generator at the station or source of electricity a conductor 5 leads to the central rail F, while a conductor 6 from the other pole leads to both the rails E, E' as shown in Fig. 23.

To the frame of the car is attached, but insulated therefrom, a arm G, carrying a roller or wheel *g* taking upon the central rail F. Connected to this arm and wheel is a conductor 4 which leads to the motor, from which a conductor 3, completing the circuit therefrom through the iron or metallic parts of the car to the rails E, E', which form the return circuit.

In practice *g* will be an extra wheel, in order to have weight sufficient to always

insure good contact even where the extra rail is oxidized, it by its weight however serving to prevent any oxidization and to keep the surface of the rail bright. In the Figures it is shown as more of a roller than a wheel, as to have shown it full size would have obscured other portions.

It is preferable to use a rail for the extra conductor, inasmuch as a large mass of conductor with little resistance is given thereby at less cost than to use a copper conductor or one specially prepared for the service, and as they are generally easy to obtain.

By using ordinary rails for F, and ordinary wheels for *g*, not special appliances need to be prepared while the change is going on, the method shown demanding in its carrying out only the materials usually on hand, or easy of obtainement and capable of use for their ordinary functions, when their use in this connection is no longer needed.

When it is attempted to use the rails of a railroad track, as herein set forth, as the conductors for an electric current, there is always more or less surface conduction, the amount depending on the hygrometric conditions of the adjacent soil, the ties, *etc.*

To largely reduce or prevent entirely this surface conduction it is preferred to use means substantially as follows:—

Between the rail and tie is placed a piece of felt, papier maché, or other flexible insulating material, preferably so treated as to make it waterproof, which piece extends upward on the web, on both sides of the rail to the head, forming an insulating shoe.

Between it and the spike is placed a piece of metal of the general configuration of the foot of the rail, upon which the head of the spike takes and bears, so that the insulating material is protected from abrasion or damage by the spike.

Instead of this metal piece a much heavier piece of wood may be used, forming a shoe fastened down by the spike, and in turn securing the rail.

The foot and web of the rails are covered with some elastic insulating composition, for example, a rubber paint, or a paint of which the base is pure linseed oil; the ties for a space of, say, one half foot to a foot on each side of the rails being similarly painted.

In order to most thoroughly insulate the third or central rail before referred to, it may be placed on the ties on a chair of glass, or other insulating material, only mortised into the tie, or laid on the tie and spiked thereto, or an insulating shield of glass may be interposed between the rail and a metallic chair.

While this chair of glass or other insulating material is here spoken of in connection with the third or central rail, it may be used with any rails forming an electric circuit.

These various forms of insulation are shown in Figs. 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36.

In Figures 24, 25, and 27, A is a piece of felting, papier maché, vulcanized fiber, or other flexible insulating material, placed under and around the rail B, and extending up the neck *a* to about the head of the rail, forming an insulating shoe.

C, Figures 24, 26, and 27, is a washer piece of metal which is placed between A and the spikes *c*, protecting A from injury by the spikes.

In place of the piece C wooden pieces D, Figure 28, may be used.

The foot *b* and web *a* of the rails are covered with some elastic insulating composition, leaving only the head of the rail exposed, or in condition to form a connection for conduction of current.

This composition may be a rubber paint, or a paint having a base of pure linseed oil or any oxidizable oil.

Fig. 29, 30, 31, 32, 33, 34, 35, and 36 show the forms of insulation referred to as especially applicable to the third or central rail, though well adapted for the insulation of any rail.

In Fig. 29 the rail is placed in a chair of insulating materia[illegible] [illegible]ber glass or

wood, the base K of the chair being of one piece, the rail resting in a recess in which it is secured by wedges L of insulating material.

In Figs. 30 & 31 the chair is of an insulating material, say, glass, made in two longitudinal halves, each having a recess the shape of half the foot of the rail, each half being slipt upon the foot.

In Fig. 30 the chair has outwardly beveled sides which take into mortices in the tie, while in Fig. 31 the chair rests upon the tie and is spiked thereto.

In Figures 32 and 33 the foot of the rail rests upon a piece *m* of insulating material, while pieces *n*, *n*, of the same material are laid on the top of the foot, half chairs *o* being placed to hold the whole together and then spiked to the tie directly as in Fig. 32, while a metallic base plate P is placed underneath in Fig. 33.

In Figures 34 and 35 an insulating bed plate *r* of the width of the foot of the rail is used, pieces R being used over the top of the foot, the whole held together in position by metallic half shoes Q spiked to the track. In Figure 34 the bed piece *r* lays upon the tie, while in Figure 35 it fits into a bevelled mortice therein.

In Fig. 36 a metallic shoe in one piece is used, in which is a large recess with bevelled sides, in which the insulating shoe composed of base V and side piece T is placed and secured therein by the wedge U.

These plans are all unitary, in that in all the foot of the rail is so surrouded by insulating material as to completely avoid the surface conduction due to contact with damp ties, *etc.*, and differ mainly in the forms given the metallic shoe which protects the insulation and serves to fasten the rail and insulation together, and both firmly to the tie.

While any insulating material may be used, the best results are attained with glass toughened by any of the know processes for toughening it. Such glass stands any jar or shock well, not breaking or craking under any ordinary wear and tear.

What is Claimed is,—

1st. A system of electrical rail roading in which a road is divided into electrical section, the rails forming the conductors, each section provided with a central station at which is located a suitable engine; a generator of electricity and means for controlling and completing the circuits to trains and to switches; cars which are electrically divided so that the motors thereon are insulated from the track; and means for completing the circuit from line of rails through the motor, substantially as set forth.

2nd. The combination with a track switch of an electric motor and circuit for operating the switch, substantially as set forth.

3rd. The combination with a car frame insulated from the track of an electric motor, an electric traction device and lamps, or of any two of them when they are arranged on multiple arc or derived circuits, substantially as set forth.

4th. The combination with a car frame of an electric engine for actuating the car, and having its inducing and field of force magnets in separate derived or multiple arc circuits, substantially as set forth.

5th. The combination with an electric engine mounted upon and actuating a car of a circuit reverser, and means for operating the reverser from a distant station, substantially as set forth.

6th. The combination with an electric engine mounted upon and actuating a car and the main driving axle of a governor receiving motion from the latter, and operating to break the circuit of the engine upon the attainement of a predetermined rate of speed, substantially as set forth.

7th. The combination with a main electrically connected rail section of a short section connected to the main section by conductors, arranged to change the polarity of the current traversing each line of rails, substantially as set forth.

8th. A car wheel constructed of a metallic hub and a metallic center united by a wooden or insulating web, substantially as set forth.

9th. A car in which an insulation is so applied that the body is electrically insulated from the flanges of the wheels, substantially as set forth.

10th. The combination with an electric engine mounted upon and actuating a car and the main driving axle of a loose or flexible connection for conveying motion from one to the other, substantially as set forth.

11th. The combination with a car of a magnet or magnets operating upon closure of circuit to increase the traction of the car upon the track by their magnetic influence, substantially as set forth.

12th. The combination with the insulated flange and the contact spring for conveying the current therefrom of several multiple arc circuits, each containing a device used in running, controlling, or lighting a car, substantially as set forth.

13th. The combination with a car of an additional grove faced wheel mounted in an adjustable bearing, means for elevating or depressing the wheels and its bearing, and a loose or flexible connection therefrom to the main driving axle, substantially as set forth.

14th. The combination of a loose friction pulley on the main driving axle, a friction pulley on the motor shaft, and a swinging or movable pulley for connecting the two, a sprocket wheel on the loose pulley, a sprocked wheel on the shaft of the grooved wheel, and a sprocket chain, substantially as set forth.

15th. The combination with the operating lever of a circuit reverser, of a cam plate normally holding the swinging levers of the reverser out of contact with their anvils and always opening one circuit before closing another, substantially as set forth.

16th. The combination upon one car of an electric engine for actuating the car, circuit reverser, a centrifugal governor acting to make or break the circuit, and a magnet or magnets operating to increase the traction of the car upon the track, substantially as set forth.

17th. The combination with main driving and ordinary wheels of a car of a wheel adapted to grasp the track and to be brought into operation as desired, substantially as set forth.

18th. The combination with the main track section of the section M T and S W, and circuit connections and switch motors, whereby trains may be passed by each other, substantially as set forth.

19th. In an electro magnetic railway engine, the combination with the motor and the driven axle of a series of variable gears and a clutch for varying the relation of speed and power as desired, substantially as shown and described.

20th. The combination with an electro magnetic railway engine of a creeper or creepers propelled along the track in one direction by the electric motor, and locking against movement in the other direction, substantially as shown and described.

21st. The combination with an arm reciprocated from the prime motor of a frame or casing and gripping devices therein, capable of sliding along a rail in one direction, but gripping and locking thereto in the opposite direction, substantially as shown and described.

22nd. The method of propulsion, substantially as shown, consisting in first sliding forward a mobile portion of the gear, then locking the same to the track, and causing the load to approach such portion, substantially as set forth.

23rd. The method of obtaining increased traction without increase of weight consisting in positively locking the motor to the track, substantially as set forth.

24th. The combination with an electro magnet of polar extensions mounted upon or attached to the cores of the magnet so as to have movement thereon to and from each other, substantially as shown and described.

25th. The combination of a disc rigidly mounted upon an axle and an electro magnet with movable polar extensions between which the disc rotates, substantially as shown and described.

26th. An electro magnetic railway brake consisting of an electro magnet

constructed to grasp between its poles a rotating portion of or attached to the running gear, substantially as set forth.

27th. The combination of a series of insulated wheels and commutator brushes on different cars of a train, and circuit connections through all upon each side respectively to the motor, substantially as set forth.

28th. The combination of an extra rail connected electrically in sections, and an extra wheel or wheels upon the car frame or car frames, but insulated therefrom, for completing the circuit, substantially as set forth.

29th. The combination of an extra insulated rail, electrically connected in sections and connected to one pole of the source of electricity, with the ordinary or traffic rails, one or both connected to form the other terminal of the source of electricity, or ground, or part of the return circuit therefor, substantially as set forth.

30th. The combination with the rail of a glass or insulating shoe, substantially as set forth.

31st. The combination with the rail and a metallic shoe of glass insulating plates interposed between the rail and shoe, substantially as set forth.

32nd. The combination with the rails of a track forming an electric circuit of an insulating cushion or shoe placed between the rails and ties, substantially as set forth.

33rd. The combination with the insulating cushion or shoe interposed between the rails and ties of a solid washer or piece placed between the spike and cushion or shoe for protecting the latter, substantially as set forth.

34th. A line of rails electrically connected to form a circuit or part of a circuit, and having the foot and web of the rails covered with an elastic insulating composition, substantially as set forth.

In witness whereof, I, the said Peter Jensen, have hereunto set my hand and seal, this Twenty second day of March, in the year of our Lord One thousand eight hundred and eighty one.

PETER JENSEN. (L.S.)

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For Her Majesty's Stationery Office.
1881.

A.D. 1880, Sep. 25, N° 3894.
JENSEN'S SPECIFICATION.

FIG. 2.

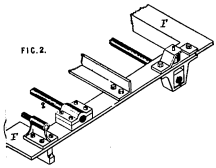
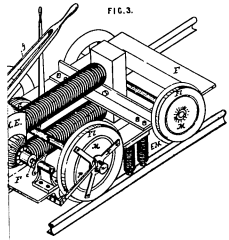


FIG. 3.



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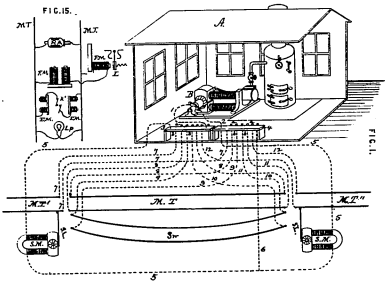


FIG. 1.

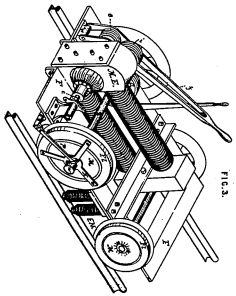


FIG. 3.

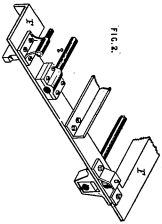


FIG. 2.

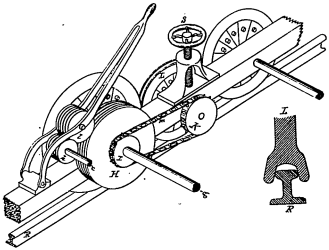


FIG. 4.

FIG. 6.

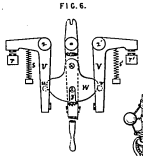
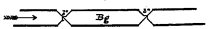


FIG. 14.



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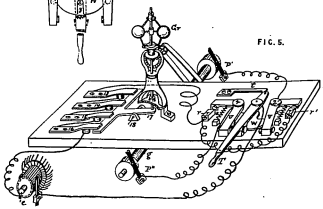

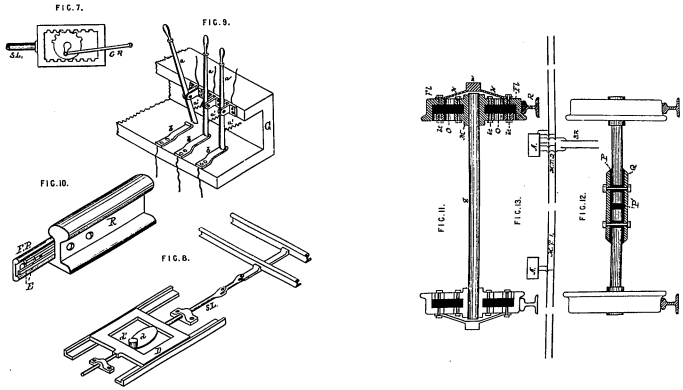

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FIG. 16.

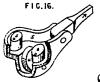


FIG. 15.

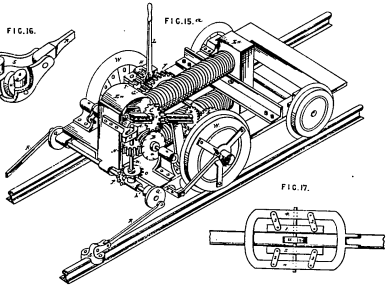
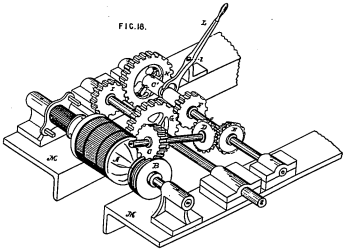


FIG. 17.

FIG. 18.



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A.D.1880. Sep.25. No. 3894.
JENSEN'S Specification.

(2 SHEETS)
SHEET 5.

FIG.19.

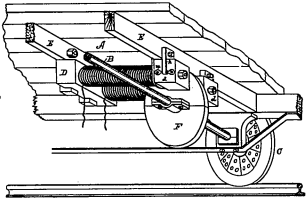

FIG.20.

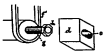

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FIG. 21.

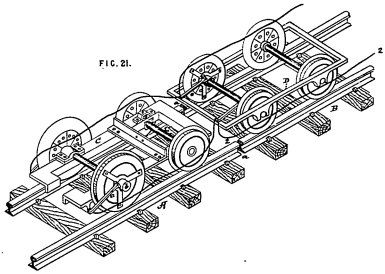
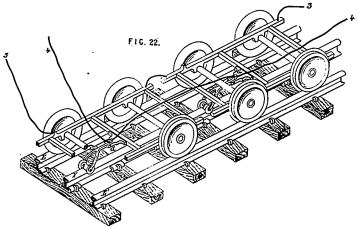


FIG. 22.



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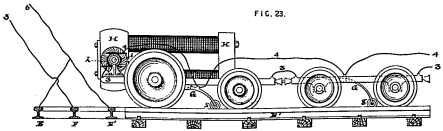

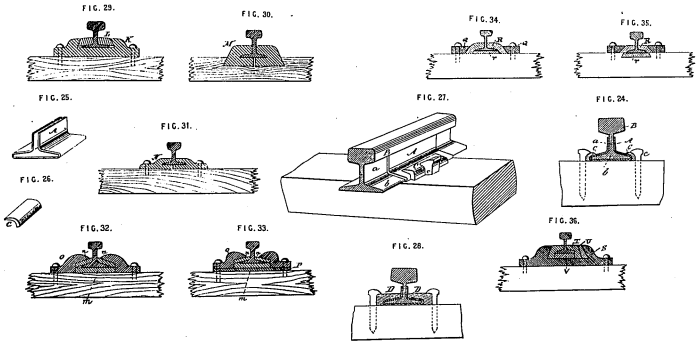

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A.D. 1880, 30th *September*. N° 3964.

Magneto-electric Machines, &c.

LETTERS PATENT to Peter Jensen, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN MAGNETO OR DYNAMO ELECTRIC MACHINES, APPLICABLE TO BOTH GENERATORS AND ENGINES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Peter Jensen at the Office of the Commissioners of Patents on the 30th September 1880.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN MAGNETO OR DYNAMO ELECTRIC MACHINES, APPLICABLE TO BOTH GENERATORS AND ENGINES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

A portion of the Invention relates to the commutator brushes.

As is well known the commutator brush generally used consists of a bundle of wires or layers of sheet metal fastened in a frame or brush holder, in such position as to bear upon and make contact with the commutator.

As hitherto constructed the brush holders have usually been rigidly attached to the frame of the machine, with some device for adjusting them to different positions with relation to the commutator, and also so attached that if a commutator brush become so damaged as to need repairs or replacement, a stoppage of the machine was necessitated.

It is important that the pressure of the brushes upon the periphery of the commutator should be constant and capable of adjustment to the desired degree, as when the pressure is too great the parts are too rapidly abraded and worn away, and when too slight, an arc may form between the opposed surfaces or portions thereof, causing them to be burnt or oxidized.

It is also important that provision should be made permitting the removal for repair or replacement of a brush without stoppage of the machine, or interference with its capacity or the current transmitted.

To accomplish these results each brush or spring is secured in a holder having an angle therein, so that the brush or spring may be set to bear obliquely upon the

[*Price* 10d.]

commutator, that is, at an angle other than a right angle with the axis of the commutator.

This holder is pivoted in a U shaped jaw in the top of what is afterwards the stem or shank of the holder.

At the pivoted point of the holder is a chamber in which is a spring, whose force is exerted to throw the brush upon the commutator, a ratchet wheel and pawl being arranged in connection therewith, so that the force of the spring may be adjusted. By this means an adjustable spring seated commutator, brush, or spring is secured.

Upon one side and near the lower end of the shank or stem is a recess, into which from below passes the end of a set screw. In front of the commutator are two metallic conducting bars, each forming one terminal of the exterior circuit.

These bars are of the size of the recess in the stems or shanks last described, and are provided with a groove in their under surface.

Upon each of these bars two, three, or more of the adjustable spring seated commutator brushes are placed by slipping the recessed portion upon the bar, they being then secured thereto by turning the set screw until its end takes in the groove in the bar.

This arrangement affords large contact surface, while at the same time any one brush may be removed for repair or replacement without interference with the generative capacity of the machine or disturbance of the current.

Another portion of the Invention relates to the combination of the prime motor with the magneto or dynamo electric machine.

In using magneto or dynamo electric machines it is very important that the armature should be rotated at an uniform and constant speed, as any variation therein immediately manifests itself in the current.

As ordinarily used, such machines are connected to the prime motor by intermediate gearing, usually belts, which are liable to slip, causing irregularity in the rotation of the armature or bobbin, every such irregularity affecting the current, causing the irregularity to be repeated and shown in the operation of whatever transmating devices are used in the circuit.

To obviate this it is preferable to connect the prime motor and the generator directly, that is, supposing the prime motor to be a steam engine, the pitman rod of the engine is connected directly to the shaft or axle of the revolving bobbin, preferably by a crank pin on a disc upon the end of the bobbin shaft, which disc is weighted upon the side opposite to the crank pin with a weight which counterbalances the weight of the pin and pitman, so that any jar or irregularity in passing dead centres is obviated; this arrangement is specially needed as the engine used should be one of very rapid stroke, not less than four hundred to five hundred per minute, in order that the bobbin may receive its needed high rate of rotation. The engine should also be what may be called "a self contained engine," that is, provided with a governor and an automatic variable cut off, which may be so adjusted that upon the speed becoming too great, the cut off shall be automatically changed to cut off at a less fraction of the stroke, and *vice versa*.

Of course, as the speed of the engine lessens the rate of the rotation of the bobbin is lessened, and consequently the electro motive force or "pressure" of the generated current drops.

If the steam engine and generator be so arranged, there is provided a system of generation in which automatically the pressure or force of the current may be maintained constant.

In manufacturing generators of large capacity, very large cores and very large castings for polar extensions are required. These very large parts cost more proportionately than small ones, and are much more difficult to handle, the winding of them requiring greater labor and care.

The greatest effect upon the cores is given by the coils nearest to it, but in using very large cores some of the coils are necessarily somewhat distant from the core.

With several smaller cores whose aggregate of weight is that of one larger core a larger surface for the action of coils may be obtained and a larger amount of wire used, whose average distance from the surface of the cores in either case is the same.

Generators of very great capacity may therefore be profitably constructed of a series (two or more) of coils and cores or field magnets, each set having its own polar extensions, but one armature or bobbin common to all being used.

By such construction, as before explained, ease and economy of construction are secured, the coils are brought on an average nearer the cores, and a greater amount of wire may be profitably used; moreover, if at any time it is desired to increase the capacity of the generator it may be done by adding more field magnets to those already in the generator, the only new part required being a proportionately longer bobbin.

As ensuring compactness and strength it is preferable to mount the engine and generator upon one base, on which is secured upon intermediate supports of a non-magnetic substance the generator, the non-magnetic supports being necessary to avoid the formation of a magnetic outside of the polar extensions.

In order to give greater rigidity and needed support to the generator the series of polar extensions are united physically by a brace or union of non-magnetic material, which in effect makes the opposite poles one structurally, but preserves them separate magnetically.

Another portion of this Invention relates to the governing or regulation of these machines when used as engines for the conversion of current into power.

Governors as usually hitherto made for such engines have been arranged to break the circuit upon the occurance of a too great speed, the circuit being again closed upon the proper lessening of the speed; but it is evident that the abnormal speed will be continued by the momentum of the parts for a greater or less interval after the breakage of the circuit.

This plan gives rise to undesirable variations in the speed of the engine, as the speed must first rise when the circuit is broken, then fall when it is again completed, thus alternating in rise and fall of speed, often giving a jerky motion to the engine and connected gearing.

The better plan would seem to be to so arrange the governor that ordinarily the abnormal or greater than desired speed should not be reached, the speed being maintained practically uniform.

The object of this Invention is to accomplish this result, and to that end it consists in a governor by which the circuit is broken at regular intervals, that is, once in every revolution of the governor, and ordinarily at a certain determined point, the engine running by momentum until the circuit be again completed, thus, so to speak, allowing the current to act through only a portion of the stroke, cutting it off then after a manner analogous to the cutting off in steam engines, the governor being also so arranged that as the speed increases the current shall be cut off and the engine run by momentum a proportionately longer time during each revolution, forming a variable automatic cut off exactly analogous to the steam engine cut off.

A centrifugal governor is arranged to be driven from some rotating part of the engine. Upon its shaft and connected with the ball arms so as to be moved up and down thereby is a sleeve composed of an insulating and a conducting portion, their line of union being a diagonal, that is, if the surface of the spindle were laid flat it would be of the shape of an italic *N*, the line between the two being the diagonal connecting the legs of the *N*. A spring bears upon this spindle and the circuit to the engine passes through the spring and spindle.

The governor is so adjusted that upon rotation at the proper speed and with the proper pressure of current, the commutator will be in the right position for the circuit to be complete during enough of each rotation of the sleeve to maintain uniform such speed.

As either additional work is given the engine to do or less current is supplied, the governor slowing will cause the current to be on for a greater portion of the

rotation, or, so to speak, will cut off at a great fraction of the stroke, or *vice versa*.

Another portion of the Invention relates to means for communicating motion from the rotating armature of an electric engine to the driven mechanism without the use of belts, gears, or other similar devices used to diminish the speed.

The best effects are obtained from electric engines when the armatures are steadily and uniformly revolved at a very high speed.

This rate of speed is oftentimes, or rather generally, greater than the rate at which it is desired to run the driven machinery; in order therefore to reduce the speed the motor and driven machinery are connected by belts or gearing, in whose use there are inherent defects, such as the slip and stretch of belts, the rattle of gear, and so forth.

The method which I have devised for this purpose may be stated in general terms as follows:—

The rotary motion of the armature is first converted into an oscillating motion, which is then converted into a continuous rotary motion in the following way:—

Upon the shaft of the armature is a balanced crank pin to which is attached a pitman or driving rod connected to an oscillating frictional pawl mechanism.

Upon the driving shaft is fixed a wheel having a frictional periphery. Loose upon the driving shaft is an arm extending a distance above the rim of the frictional wheel, and then bent over and fashioned into a frame, in which are pivoted two pawls connected together by a frame capable of being shifted, so that only one pawl can take at the time upon the wheel.

The pawls are so constructed that they communicate motion in opposite directions, hence the direction of rotation of the driving wheels depends upon which one of the pawls is used.

The arm carrying the pawls is slotted, and the pitman or driving rod is connected thereto by a pin whose position is adjustable in the slot, so that the leverage may be adjusted and the speed communicated easily varied.

The arrangement described is used in duplicate; that is, two or more driving rods communicate motion from the armature shaft to as many frictional pawls and driving wheels on the driven shaft, the crank pins being so arranged relatively to each other that a continuous motion is imparted to the driven shaft, and mechanism connected therewith.

Upon the driven shaft is loosely mounted the fly wheel and main driving pulley, a clutch being used to fasten them to the shaft when it is desired to communicate motion, so that the machinery may be stopped without stopping the motor itself.

Some methods by which power could be readily and economically transferred to a distance from a prime motor has long been felt to be desirable, and to that end many suggestions have been made and plans devised involving its transfer by ropes, by compressed air, and by electricity.

Practically it has been determined that the power of a prime motor may be converted into electricity, and the electricity conveyed to a distance to be re-translated into power; this, however, only to a limited extent and by the use of very large conductors, for to transmit power to any great distance without the use of large and costly conductors, requires that the current should have very great electro-motive force or "pressure," say as much as two thousand to three thousand volts. In practice, with magneto or dynamo electric machines as now built, it is impracticable to generate currents of such high electro-motive force.

These machines have but a single bobbin, and the difference of potential between one section of wire upon the bobbin and another would be very great.

Against so great a difference of potential it is extremely difficult to guard even by the most careful winding and insulation.

The result, especially in damp weather or when the bobbins become damp, that the currents break a short path from section to section, burning the wires.

In addition such great electro-motive force causes a large increase of destructive spark at the commutators.

If currents of such electro motive-force could be safely and economically generated and translated, exceedingly small and inexpensive conductors relatively could be used to transfer, without material loss, a very large amount of power, say, several hundred horse power.

Another object of this Invention then is to furnish means and methods by which this transmission may be made.

In systems of this kind a prime motor is used which may be an air, steam, water, engine, windmill.

A high speed engine should be used geared directly to the generator.

When a water wheel is used, such as are now ordinarily used, on account of the low speed with ordinary heads of water it would have to be connected to the generator by gearing, ordinarily belts, arranged to increase the speed so as to give the bobbin a sufficiently rapid rotation. The use of belts or gearing however involves loss of power and irregularity.

Still another object of this Invention then is to so arrange water wheels in connection with generators that the wheel and generator may be connected directly and without intermediate gearing, and still the necessary high speed obtained.

To accomplish these last named results a battery of generators is used, each separate and complete in itself, but with all the rotating armatures or bobbins (each provided with its own commutator) mounted upon the same driving shaft, the total electro-motive force of all the bobbins being equal to the electro-motive force desired.

By thus dividing it between a number of bobbins it is lessened in each bobbin, with a consequent reduction of difference of potential between the layers or sections on each bobbin.

The motors or re-translating engines are divided up in the same way, all the bobbins, each having its own commutator, being mounted upon the one driving shaft, upon which they all exert their force.

Where a water wheel is used with a fall only sufficient to give a low rate of speed it should be used to actuate a pumping apparatus, raising the water to a high whence it may flow under great head or pressure to a smaller wheel geared directly to the generator, the increased head of water and small size of the second wheel resulting in an accelerated velocity. This plan is followed because the loss in pumping and using the pumped water to drive the second wheel is less than the loss due to gearing by belts and such like a slow moving wheel to the generator, in such manner as to give the desired high velocity.

By the arrangement thus generally stated it is possible and commercially practicable to convert even several thousand horse power of a prime motor into electricity, convey the electricity by moderate sized or even very small conductors to a distance, there to be reconverted into power.

In addition, for the best results, certain relations must exist between the generator and engines.

In using generators to produce a current, which is supplied to an electric engine, the practice hitherto has been to make the generator or transmitting machine and the engine or receiving machine exactly alike, so that when each is rotating at same speed the counter electro-motive force of the receiver exactly equals the electro-motive force of the generator. In such cases, when no work is being done, the tendency of the engine or receiver is to acquire that rate of speed which is necessary to make the counter and the prime electro-motive force, equal. As work is given the engine to do, its speed, and consequently its counter electro-motive force, is reduced, but when both are made alike, and have, when doing no work, equal forces, it has not been found desirable to load the engine or receiver beyond the point reducing its speed, and consequently its counter electro-motive force, more than one half.

The difference between the electro-motive force and the counter electro-motive

force (of course less friction, for example), represents the amount of current transferred into power, which in most cases is not more than fifty per cent.

Instead of the arrangement described the bobbins of the receiving machines or engines are wound so that when driven at the same speed as the generators or transmitters their counter electro-motive force shall be only one half, or even less, that of the transmitters.

Unloaded then, as their tendency is to run at the rate which shall develope the same electro-motive force, they rotate at twice the speed of the generators.

Now if they are so loaded with work as to reduce their speed to the same as that of the transmitters they develope only half their unloaded counter electro motive force, turning fifty per cent. into power at that rate.

It is preferable to load the engine with work only to that point which permits of a speed not less than that of the generator, and usually somewhat greater, so that the counter electro-motive force developed shall be about seventy five per cent. of the prime electro motive force, at about which point is the greatest economical conversion into force. In connecting up the generators and engines the same plan may be followed in both.

As stated previously but a small current is required to keep up to the point of magnetic saturation field magnets once brought to that point.

Where all the current generated is taken through the coils of the field of force magnets there is many times as much current as needed for the purpose, and the resistance of the field coils is uselessly added to the circuit of the current, consequently it is preferred to use only part of the current, arranging a shunt circuit to the bobbin of one or all the machines, which shunt passes around and energizes the fields of the whole series; the resistance of the fields is proportioned to the electro-motive force of the bobbin, so that only the proper proportion of current will pass through the shunt, that is, just enough to keep the field magnets up to the point of economical magnetic saturation.

The common type of armature used at present is one composed of a number of coils wound longitudinally over a single core, the coils crossing each other at the ends where there is a large and cumbersome mass of wire.

If by any chance one or more coils are injured or destroyed the repairment is a difficult and tedious process. If such coils were among the first put on those which overlap at the ends must be removed before the injured ones can be removed.

It seems desirable that such provision be made that any coil can be removed or repaired without disturbance of the remainder.

Another portion of the Invention therefore relates to a construction for attaining this object.

This is accomplished by making of wire only that portion of the coil which is upon the operative face, the wires of a coil being connected at the ends by metallic plates fastened to an insulating base and insulated from each other. These plates are made so as to project at the proper points above the general surface of the core, at which points the wires are secured to them by soldering, brazing, or clamping devices. At one end each plate is suitably connected to the proper commutator block.

In case of necessity of removal of any coils it is unloosed from its plates at each end without disturbance of other coils. In fact, by such construction it is possible to remove, repair, and replace any coil without taking the armature out of the machine and with but a slight stoppage of the machine.

The plates upon the end are made as concentric almost semicircles insulated from each other with the projections for receiving the wires nearly at right angles thereto.

These plates offer less resistance than the wire, and consequently the internal resistance of the generator is proportionately reduced.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Peter Jensen in the Great Seal Patent Office on the 30th March 1881.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN MAGNETO OR DYNAMO ELECTRIC MACHINES, APPLICABLE TO BOTH GENERATORS AND ENGINES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

A portion of the Invention relates to the commutator brushes.

As is well known the commutator brush generally used consists of a bundle of wires or layers of sheet metal fastened in a frame or brush holder in such position as to bear upon and make contact with the commutator.

As hitherto constructed the brush holders have usually been rigidly attached to the frame of the machine, with some device for adjusting them to different positions with relation to the commutator, and also so attached that if a commutator brush become so damaged as to need repairs or replacement a stoppage of the machine was necessitated.

It is important that the pressure of the brushes upon the periphery of the commutator should be constant and capable of adjustment to the desired degree, as when the pressure is too great the parts are too rapidly abraded and worn away, and when too slight an air may form between the opposed surfaces or portions thereof, causing them to be burnt or oxidized.

It is also important that provision should be made permitting the removal for repair or replacement of a brush without stoppage of the machine or interference with its capacity or the current transmitted.

To accomplish these results each brush or spring is secured in a holder having an angle therein, so that the brush or spring may be set to bear obliquely upon the commutator, that is, at an angle other than a right angle with the axis of the commutator. This holder is pivoted in an U shaped jaw in the top of what is afterwards the stem or shank of the holder. At the pivoted point of the holder is a chamber, in which is a spring whose force is exerted to throw the brush upon the commutator, a ratchet wheel and pawl being arranged in connection therewith, so that the force of the spring may be adjusted. By this means an adjustable spring-seated commutator brush or spring is secured. Upon one side and near the lower end of the shank or stem is a recess, into which from below passes the end of a set screw.

In front of the commutator are two metallic conducting bars, each forming one terminal of the exterior circuit. These bars are of the size of the recess in the stems or shanks last described and are provided with a groove in their under surface. Upon each of these bars two, three, or more of the adjustable spring seated commutator brushes are placed by slipping the recessed portion upon the bar, they being then secured thereto by turning the set screw until its end takes in the groove in the bar.

This is fully illustrated in Figures 1, 2, and 3 of the annexed Drawings, in which

Figure 1 is a view of a commutator and series of commutator brushes embodying the Invention.

Figure 2 is a side view of one brush holder; and

Figure 3 a longitudinal section of part of one brush holder.

A is the commutator of a dynamo or magneto electric machine placed as usual at the end of the rotating armature B, and supported at its outer end in bearings C; a, a, being the strips thereof connected to the coils of the armature, but insulated from each other. At a suitable distance from the commutators square bars D, D, at

are supported in (but insulated from) supports D^1, D^1, (one of which only is shown).

The brush holders are made in two pieces E, F, the part E being formed with an U shaped recess or jaw at its upper end, in which takes and in which is pivoted the part F. A pin or pivot *i* passes through the two parts and holds them together. In the lower portion of the part F a chamber is formed, in which is placed the spring *h*, whose inner end is attached to *i*, the outer end being fast to the wall of the chamber. Upon the end of *i*, outside of the chamber is a ratchet wheel *k*, a pawl *m* being arranged upon E to take into the teeth of *k*, and hold it in a fixed position. In the upper or free end of F is a chamber or recess *f* for receiving and holding a brush which is secured therein by a set screw *e*. Upon the inner side of E is cut a groove the size of the bar D, in the under side of which is cut a slot, as shown in Figures 2 and 3.

A series of commutator brush holders thus constructed are placed side by side upon the bars D, D, by simply slipping each on to the bar from the front, each being secured thereon by the set screws *d*, taking into the groove in D.

The use of a series, as shown, involves several advantages. Each series of brushes is in metallic contact at the same time with the same strip or strips of the commutator, hence sparks between the commutator and brushes are greatly lessened, if not entirely obviated, even with a very large current. If repairs upon or replacement of one or more brushes be necessary the set screws *d* of the defective brushes are loosened, and the holders of such defective brushes removed from the bar D without disturbance of the remaining brushes which afford ample contact surface.

As before stated the ratchet *k* is upon the pivot *i*, to which is attached the spring *h*, hence by turning the ratchet *k* any desired degree of resilience may be given the spring, which force is expended in holding the brushes upon the commutator with a steady and uniform pressure, which may be varied or regulated by means of the ratchet. This arrangement affords a large contact surface, while at the same time any one brush may be removed for repair or replacement without interference with the generative capacity of the machine or disturbance of the current, and to it is given the name "large current multiple brushes.

Another portion of the Invention relates to the combination of the prime motor with the magneto or dynamo electric machine.

In using magneto or dynamo electric machines it is very important that the armatures should be rotated at an uniform and constant speed, as any variation therein immediately manifests itself in the current. As ordinarily used such machines are connected to the prime motor by intermediate gearing, usually belts, which are liable to slip, causing irregularity in the rotation of the armature or bobbin, every such irregularity affecting the current, causing the irregularity to be repeated and shown in the operation of whatever translating devices are used in the circuit.

To obviate this it is preferable to connect the prime motor and the generator directly, that is, supposing the prime motor to be a steam engine, the pitman rod of the engine is connected directly to the shaft or axle of the revolving bobbin, preferably by a crank-pin on a disk upon the end of the bobbin shaft, which disk is weighted upon the side opposite to the crank pin with a weight which counterbalances the weight of the pin and pitman, so that any jar or irregularity in passing dead centers is obviated. This arrangement is specially needed, as the engine used should be one of very rapid stroke, not less than four hundred to five hundred per minute, in order that the bobbin may receive its needed high rate of rotation. The engine should also be what may be called a "self contained engine," that is, provided with a governor and an automatic variable cut off, which may be so adjusted that upon the speed becoming too great, the cut-off shall be automatically changed to cut off at a less fraction of the stroke, and *vice versa*.

Of course as the speed of the engine lessens, the rate of rotation of the bobbin is lessened, and consequently the electro motive force or pressure of the generated

current drops. If the steam engine and generator be so arranged, there is provided a system of generation, in which automatically the pressure or force of the current may be maintained constant.

In manufacturing generators of large capacity, very large cores and very large castings for polar extensions are required. These very large parts cost more proportionately than small ones, and are much more difficult to handle, the winding of them requiring greater labor and care. The greatest effect upon the cores is given by the coils nearest to it, but in using very large cores some of the coils are necessarily somewhat distant from the core. With several smaller cores, whose aggregate of weight is that of one larger core, a larger surface for the action of coils may be obtained, and a larger amount of wire used, whose average distance from the surface of the cores in either case is the same. Generators of very great capacity may therefore be profitably constructed of a series (two or more) of coils and cores, or field magnets, each set having its own polar extensions, but one armature or bobbin common to all being used.

By such construction, as before explained, ease and economy of construction are secured, the coils are brought on an average nearer the core, and a greater amount of wire may be profitably used. Moreover, if at any time it is desired to increase the capacity of the generator, it may be done by adding more field magnets to those already in the generator, the only new part required being a proportionately longer bobbin.

As ensuring compactness and strength, it is preferable to mount the engine and generator upon one base, on which is secured, upon intermediate supports of a non-magnetic substance, the generator, the non-magnetic supports being necessary to avoid the formation of a magnetic circuit outside of the polar extensions. In order to give greater rigidity and needed support to the generator, the series of polar extensions are united physically by a brace or union of non-magnetic material, which in effect makes the opposite poles one structurally, but preserves them separate magnetically.

This is illustrated in Figure 4 of the Drawings, which represents a prime motor and a generator united and constructed, as before set forth.

L is a suitable base, preferably of cast iron, upon which is secured the individual base M of the steam engine. This base M may be cast in one piece with L, or it may be made separate and properly fastened thereon; A is the cylinder of the engine provided with the usual throttle valve *a*, and with steam chest, &c., not shown in the Drawing.

The piston rod B connects to pitman *b*, which takes on a crank pin on the disc C, to which is secured a block or weight which counter balances the weight of the crank-pin and the pitman *b*. The disc C is mounted upon the shaft *c*, which also carries the revolving armature or bobbin, and is therefore both the engine and bobbin shaft, and may be termed properly either a bobbin or an engine shaft. The engine is provided with a governor G, rotated as usual from some rotating part of the machinery, and attached to a variable cut off, so as to automatically vary the cut-off, reducing or increasing the speed by lengthening or shortening the proportion of the stroke during which steam is admitted. E, E^1, E^{11}, represent three series of field of force magnets, each series forming one magnet, the cores of whose coils are connected by a back piece or yoke; e, e^1, e^{11}, being the yokes of E, E^1, E^{11}, respectively. Each magnet is provided with its own polar extensions, one for each pole, as F, F^1, F^{11}, which form one pole of each magnet, the other pole being lid by the plate H and base I in the Drawing. These poles are separated slightly from each other, affording opportunity for the passage of air on all sides of each one. For compactness these magnets are placed horizontally instead of vertically. In order then to give necessary rigidity, and ensure the proper distance between the poles for the rotation of the bobbin, a plate H of non-magnetic material is bolted to them. Upon the shaft c is the bobbin or armature E^4 formed on a sleeve D which is keyed to the shaft c. This bobbin is of an effective length, equal to the length of the aperture formed by the polar extensions, and in which it

is to rotate. In addition to performing its function as a bobbin or armature, the bobbin is so proportioned that it acts as a fly or balance wheel to the engine.

In order to prevent a magnetic circuit being formed outside of the magnets non-magnetic material I, K, is placed between the generator and base L.

If the generator were purely a dynamo machine any drop in the pressure or force in the circuit, due to increased resistance or work in the circuit, would be immediately felt in the field coils themselves, whereas it is preferable that such current should not be so affected. In order to maintain the pressure uniform so far as regards such disturbances, it is well to use a small auxilliary dynamo generator as the source of the current for the field-magnets.

The bobbin of such auxilliary generator may be placed upon a prolongation of the shaft *c*, and its current passed through the field of force coils E, E^1, E^{11}. These field of force coils may be connected in one circuit as a series; or they may be connected to the field of force circuits by derived circuits, as a "multiple arc" circuit.

While in the Drawing only three series of magnets are shown, it is evident that two, or any increased number, may be used. It is further evident, given a generator of certain capacity, that its capacity may at any time be increased by the addition of more series of magnets, without the necessity of re-modeling the the machine, further than the providing of a proportionately longer bobbin.

Another portion of this Invention relates to the government or regulation of these machines when used as engines for the conversion of current into power. Governors as usually hitherto made for such engines have been arranged to break the circuit upon the occurrence of too much speed, the circuit being again closed upon the proper lessening of the speed, but it is evident that the abnormal speed will be continued by the momentum of the parts for a greater or less interval after the breakage of the circuit. This plan gives rise to undesirable variations in the speed of the engine, as the speed must first rise when the circuit is broken, then fall when it is again completed, thus alternating in rise and fall of speed, often giving a jerky motion to the engine and connected gearing. The better plan would seem to be to so arrange the governor that ordinarily the abnormal, or greater than desired, speed should not be reached, the speed being maintained practically uniform.

The object of this part of the Invention is to accomplish this result, and to that end it consists in a governor by which the circuit is broken at regular intervals, that is, once in every revolution of the governor, and ordinarily at a certain determined point, the engine running by momentum until the circuit be again completed, thus, so to speak, allowing the current to act through only a portion of the stroke, cutting it off then, after a manner analogous to the cutting off in steam engines, the governor being also so arranged that as the speed increases the current shall be cut off and the engine run by momentum a proportionately longer time during each revolution, forming a variable automatic cut off exactly analogous to the steam engine cut off.

A centrifugal governor is arranged to be driven from some rotating part of the engine. Upon its shaft, and connecting with the ball-arms so as to be moved up and down thereby, is a sleeve composed of an insulating and a conducting portion, their line of union being a diagonal, that is, if the surface of the spindle were laid flat it would be of the shape of an italic *N*, the line between the two being the diagonal connecting the legs of the *N*. A spring bears upon the spindle, and the circuit to the engine passes through the spring and spindle. The governor is so adjusted that upon rotation at the proper speed, and with a proper pressure of current, the commutator will be in the right position for the circuit to be complete during enough of each rotation of the sleeve to maintain uniform such speed.

As either additional work is given the engine to do, or less current is supplied, the governor slowing will cause the current to be on for a greater portion of the rotation, or, so to speak, will cut off at a greater fraction of the stroke, or *vice versa*. Figure 5 of the Drawings illustrate such a governor.

A is a centrifugal ball governor composed of two balls, attached to the fly rods which are pivoted in supports fixed upon the shaft B, which is mounted in suitable bearings, and receives motion by means of a cord or belt passing around the pulley C and connecting it to some moving part of the engine. The links *a*, *a*, of the governor are pivoted to a sleeve *b*, to which is attached a commutator D, both arranged to slide up and down upon the shaft B. The commutator D is made of a conducting portion *d* and insulating portion d^1, each cut diagonally and united at their diagonal edges. The circuit to the engine passes by conductor 1 to the shaft B, then by the conducting portion *d* to spring *e* supported on but insulated from the frame of the governor, and thence to 2. The governor is so adjusted that upon rotation at the proper speed and with the proper pressure of current the commutator will be in the right position for the circuit to be complete during enough of each rotation of D to maintain uniform such speed. As either additional work is given the engine to do, or less current is supplied, the governor slowing will cause the current to be on for a greater portion of the rotation, or, so to speak, will cut off at a greater fraction of the stroke, or *vice versa*.

Another portion of the Invention relates to means for communicating motion from the rotating armature of an electric engine to the driven mechanism without the use of belts, gears, or other similar devices used to diminish the speed.

The best effects are obtained from electric engines when the armatures are steadily and uniformly revolved at a very high speed. This rate of speed is oftentimes, or rather generally, greater than the rate at which it is desired to run the driven machinery. In order therefore to reduce the speed, the motor and driven machinery are connected by belts or gearing, in whose use there are inherent defects, such as the slip and stretch of belts, the rattle of gears, &c.

The method which is devised for this purpose may be stated in general terms as follows:—The rotary motion of the armature is first converted into an oscillatory motion, which is then converted into a continuous rotary motion in the following way:—Upon the shaft of the armature is a balanced crank pin, to which is attached a pitman or driving rod connected to and oscillating a friction pawl mechanism. Upon the driving shaft is fixed a wheel having a frictional periphery. Loose upon the driving shaft is an arm extending a distance above the rim of the frictional wheel, and then bent over and fashioned into a frame, in which are pivoted two pawls connected together by a frame capable of being shifted, so that only one pawl can take at a time upon the wheel. The pawls are so constructed that they communicate motion in opposite directions, hence the direction of rotation of the driving wheels depends upon which one of the pawls is used. The arm carrying the pawls is slotted, and the pitman or driving rod is connected thereto by a pin, whose position is adjustable in the slot so that the leverage may be adjusted, and the speed communicated easily varied. The arrangement described is used in duplicate, that is, two or more driving rods communicate motion from the armature shaft to as many frictional pawls and driving wheels on the driven shaft, the crank pins being so arranged relatively to each other, that a continuous motion is imparted to the driven shaft and mechanism connected therewith.

Upon the driven shaft is loosely mounted the fly wheel and main driving pulley, a clutch being used to fasten them to the shaft when it is desired to communicate motion, so that the machinery may be stopped without stopping the motor itself. This system of devices is more clearly shown in the Drawings, in which Figure 6 is a perspective view of the driven mechanism detached from Figure 7, which is a perspective of a motor engine complete. Figure 8 shows the application thereof to a locomotive, and Figure 9 its application to a pump, it being understood however that the Invention is applicable to many other uses, these being shown as types.

In Figure 7 is shown an electric engine composed of magnets M, M, yoke Y, polar extensions P, P, and rotary armature A, the commutator springs or brushes being removed, in order not to obscure the view of the other parts. Driven from some rotating part of the machinery is a governor G which operates a circuit

breaker, adapted to make or break the circuit at a number of points simultaneously. This circuit breaker is merely arbitrarily indicated at G^1, its con-truction, operation, and functions being more fully shown or explained in prior Patents granted to said Edison. Upon the shaft b of the armature A is a disk a, on which is the crank pin c. The disk a is weighted upon one side or cut away so as to be balanced. Loosely pivoted upon the shaft d of the driving wheel D is the arm g extending above D, and formed into the frame i, in which are pivoted the pawls k, k^1, connected together by the shifting frame m, by which one or the other may be brought into contact with the periphery of D. In g is the slot h, in which is secured the pin f. A pitman or driving rod e is connected at one end to pin e, and at the other to pin f. As the distance of pin f from its center d is always greater than that of e from the center b, the rotation of a communicates only an oscillating motion to g. The pawls are so fashioned, as shown, that in movement in one direction they slide over the face of D, while in the reverse movement they lock to the face and move D. As shown, the pawl k is in use. If a rotates in the direction of its arrow, k during the forward half of a's rotation slides over the face of D, but upon the rearward half rotates D with it in the direction of the arrow marked thereon. In practice two or more sets are used, as shown at 2, 3, in Figure 7, so that a constant motion is secured instead of the intermittent action due to one only. If desired to reverse the motion, the frame m is moved to the left, fitting k from contact with D, at the same time putting k^1 in contact therewith. Any suitable device may be used for holding the frame m in the position to which it is moved. Upon the shaft d is mounted loosely the fly wheel F and driving pulley E, a clutch C with lever L being used to connect E, F, to the shaft d, so that the movement of the driven machinery may be controlled without subjecting the motor itself to the objectionable effects of sudden starts and stoppages.

In Fig. 8 the engine is shown mounted upon a wheeled frame, driving wheels D w being substituted for the fly wheel and pulley, constituting an efficient locomotive.

In Figure 9 a pump P r is shown connected directly by pitman r to a crank cr on shaft d. By thus connecting directly instead of through the medium of intermediate gearing increased efficiency of service is secured. Some method by which power could be readily and economically transferred to a distance from a prime motor has long been felt to be desirable, and to that end many suggestions have been made and plans devised, involving its transfer by ropes, by compressed air, and by electricity.

Practically it has been determined that the power of a prime motor may be converted into electricity, and the electricity conveyed to a distance to be re-translated into power, this however only to a limited extent; and by the use of very large conductors for to transmit power to any great distance without the use of large and costly conductors requires that the current should have very great electro-motive force or "pressure," say, as much as two thousand to three thousand volts.

In practice with magneto or dynamo electric machines as now built, it is impracticable to generate currents of such high electro-motive force. These machines have but a single bobbin, and the difference of potential between one section of wire upon the bobbin and another would be very great. Against so great a difference of potential it is extremely difficult to guard, even by the most careful winding and insulation. The result, especially in damp weather or when the bobbins become damp, is that the currents break a short path from section to section, burning the wires. In addition, such great electro-motive force causes a large increase of destructive spark at the commutator. If currents of such electro motive force could be safely and economically generated and translated, exceedingly small and inexpensive conductors relatively could be used to transfer without material loss a very large amount of power, say, several hundred horse power.

Another object of this Invention then is to furnish means and methods by which

this transmission may be made. In systems of this kind a prime motor is used which may be an air, steam, or water motor, or windmill. A high speed engine should be used, geared directly to the generator. When a water wheel is used, such as are now ordinarily used on account of the low speed with ordinary heads of water, it would have to be connected to the generator by gearing, ordinarily belts, arranged to increase the speed so as to give the bobbin a sufficiently rapid rotation. The use of belts or gearing however involves loss of power and irregularity. Still another object of this Invention then is to so arrange water wheels in connection with generators that the wheel and generator may be connected directly and without intermediate gearing, and still the necessary high speed obtained. To accomplish these last named results a battery of generators is used, each separate and complete in itself, but with all the rotating armatures or bobbins (each provided with its own commutator) mounted upon the same driving shaft, the total electro-motive force of all the bobbins being equal to the electro-motive force desired. By thus dividing it between a number of bobbins it is lessened in each bobbin, with a consequent reduction of difference of potential between the layers or sections on each bobbin.

The motors or re-translating engines are divided up in the same way, all the bobbins, each having its own commutator, being mounted upon the one driving shaft, upon which they all exert their force. Where a water wheel is used with a fall only sufficient to give a low rate of speed, it should be used to actuate a pumping apparatus, raising the water to a height, whence it may flow under great head or pressure to a smaller wheel geared directly to the generators, the increased head of the water and small size of the second wheel resulting in an accelerated velocity. This plan is followed because the loss in pumping and using the pumped water to drive the second wheel is less than the loss due to gearing by belts, &c. a slow moving wheel to the generator in such manner as to give the desired high velocity. By the arrangement thus generally stated it is possible and commercially practicable to convert even several thousand horse power of a prime motor into electricity, and convey the electricity by moderate sized or even very small conductors to a distance, there to be reconverted into power. In addition for the best results certain relations must exist between the generators and engines. In using generators to produce a current which is supplied to an electric engine the practice hitherto has been to make the generator or transmitting machine and the engine or receiving machine exactly alike, so that when each is rotating at same speed the contrary electro motive force of the receiver exactly equals the electro motive force of the generator. In such cases when no work is being done the tendency of the engine or receiver is to acquire that rate of speed which is necessary to make the counter and the prime electro-motive force about equal. As work is given the engine to do its speed, and consequently its counter electro-motive force, is reduced, but when both are made alike, and have when doing no work equal forces, it has not been found desirable to load the engine or receiver beyond the point reducing its speed and consequently its counter electro-motive force more than one half. The difference between the electro motive force and the counter electro motive force (of course less friction, &c.) represents the amount of current transferred into power, which in most cases is not more than fifty per cent.

Instead of the arrangement described, the bobbins of the receiving machines or engines are wound so that when driven at the same speed as the generators or transmitters their counter electro motive force shall be only one half, or even less, that of the transmitters. Unloaded then, as their tendency is to run at the rate which shall develop the same electro-motive force, they rotate at twice the speed of the generators. Now, if they are so loaded with work as to reduce their speed to the same as that of the transmitter, they develop only half their unloaded counter electro motive force, turning fifty per cent. into power at that rate. It is preferable to load the engine with work only to that point which permits of a speed not less than that of the generator, and usually somewhat greater, so that the counter electro motive force developed shall be about seventy-five per cent. of

the prime electro motive force, at about which point is the greatest economical conversion into force. In connecting up the generators and engines the same plan may be followed in both. As stated previously, but a small current is required to keep up to the point of magnetic saturation field magnets once brought to that point. Where all the current generated is taken through the coils of the field of force magnets, there is many times as much current as needed for the purpose, and the resistance of the field coils is uselessly added to the circuit of the current, consequently it is preferred to use only part of the current, arranging a shunt circuit to the bobbin of one or all the machines, which shunt passes around and energizes the field of the whole series. The resistance of the fields is proportioned to the electro motive force of the bobbin, so that only the proper proportion of current will pass through the shunt, that is, just enough to keep the field magnets up to the point of economical magnetic saturation. In Figure 10 of the Drawings is shown this arrangement described, so far as may be shown in Drawings.

E is a battery of generators, which may be of any desired number, six A, A, A, A, A^1, being shown, their rotating armatures or bobbins and commutators being upon a shaft e^1 common to them all, which is driven from any suitable prime motor, represented arbitrarily by *x*. In this case the bobbins of the entire battery are connected in a series by wires 3, 3, extending from the commutator brush of one generator to that of the next, conductors 2, 4, attached to the terminal binders of the battery leading to and from the battery G of engines or translating devices. From the commutator connections of A^1 a shunt circuit is formed 5, 5, which passes from P through the coils of all the field of force magnets of the series returning to P^1. G is a battery of engines or receivers having bobbins wound as explained, so as to have, when doing no work, a speed of twice that of the bobbins of the generators in order to develop a counter electro motive force equal to the electro motive force of the generators. The bobbins and commutators are placed on a shaft *c* common to them all, which shaft is suitably connected to the machinery to be driven, which connection is represented in this instance by pulley P^2 on shaft *c*, belt D and pulley P^1 on shaft *s*, which conveys the power to the driven machines. The current comes from the generators, say, by wire 2, passes to the commutator of the first engine *c*, thence by wires 1, 1, through the commutators of the remainder in series, and by wire 13 and 4 back to the generators. A shunt circuit 14 to the commutator of C^1 leads through the coils of all the field of force magnets, the resistances of the shunts in both instances being proportioned as herein before explained. Instead of the generators and engines being arranged in series as shown, they may if deemed desirable be arranged, either or both, on the multiple arc system, in which cases the relative resistances of the parts must be adjusted to compensate for the difference in resistance of a circuit inherent upon arrangement of devices in series or in derived circuits. The engine of the battery G need not be located at one place as shown, but may be distributed, as, for instance, through a village which is remote from the source of supply, or station where E is located. In such case a small dynamo may be placed in the circuit 2 at the village or locality, and the current therefrom used to excite the field magnets of the engines, a local circuit leading from and to the dynamo through all the field coils of the engines there located. Instead of the bobbins being wound differently so as to require different speeds for the same electro motive forces, the number of engines or receiving machines used may be less than that of the generators, for instance, as shown in Figure 10, with six generators four engines may be used, with the result, in order to give the same electro motive force, that the receivers run with much greater speed than the generators. The common type of armature used at present is one composed of a number of coils wound longitudinally over a single core, the coils crossing each other at the ends, where there is a large and cumbersome mass of wires. If by any chance, one or more coils are injured or destroyed, the repairment is a difficult and tedious process. If such coils were among the first put on, those which overlap at the ends must be removed before the injured ones can be reached.

It seems desirable that such provision be made that any coil can be removed or repaired without disturbance of the remainder.

Another portion of this Invention, therefore, relates to a construction for attaining this object. This is accomplished by making of wire only that portion of the coil which is upon the operative face, the wires of a coil being connected at the ends by metallic plates fastened to an insulating base, and insulated from each other. These plates are made so as to project at the proper points above the general surface of the core, at which points the wires are secured to them by soldering, brazing, or clamping devices. At one end each plate is suitably connected to the proper commutator block. In case of necessity of removal of any coil it is unloosed from its plates at each end without disturbance of other coils. In fact, by such construction, it is possible to remove, repair, and replace any coil without taking the armature out of the machine, and with a slight stoppage of the machine.

This part of the Invention may be carried into effect by means substantially such as shown in Figure 11 of the Drawings, wherein C is the commutating end, and A the other end of the armature.

Upon suitable insulating bases circular in form, the radial metal plates numbered 1 to 18, in A and C, are secured, insulated from each other, as indicated by the black space between them.

Upon A the circular plate or bar *a* connects 1 and 10; *b*, 2 and 11; *c*, 3 and 12; *d*, 4 and 13; *e*, 5 and 14; *g*, 6 and 15; *h*, 7 and 16; *i*, 8 and 17; *k*, 9 and 18. Each of these bars is insulated from the other, and from all the plates excepting those which it is designed to connect. It will be noticed that upon this end the circular bars connect exactly opposite coils, as would the wires ordinarily used.

Upon the commutating end C the arrangement is somewhat different. Upon it 1 and 12 are connected by *m*, 2 and 3 by *n*, 3 and 14 by *o*, 4 and 11 by *p*, 5 and 16 by *q*, 6 and 13 by *r*, 7 and 18 by *s*, 8 and 15 by *t*, 10 and 17 by *u*. These bars are insulated, as before stated in the case of A.

Upon the commutating end the odd numbered radial bars are bent outwardly at a right angle at their inner end, the bent portions *v*, *v*, being secured to a hub and forming the commutator.

To these end disks, thus constructed, are secured wires, ribbons, or bars, in any suitable manner, forming with the radial and circular plates the coils. For large machines it is preferred to use naked bars of copper B^1, B^1, which are secured in the recesses shown in the outer edges of the radial plates. They will be sufficiently insulated from each other by the air space between them. If bars are used not sufficiently rigid to preserve their relative distances from each other throughout their length, stays or blocks of insulating material, such as mica, may be placed between them at proper intervals.

By the arrangement of connections and the commutator as shown in C all the coils are constantly in circuit, the generated current having the electro motive force of a coil of the total length of all the coils, while the internal resistance is kept low by the lessening of resistance in the ends, due to the much larger mass of conductor in section of the plates and bars over that of the wires ordinarily used, while the resistance of the active parts, when bars are used, as described, is also greatly lessened.

Supposing the parts are in such position that the commutator brushes are in connection with 5 and 15, the path of the generated currents will be as follows:—Starting, say, at the brush on 5, the path in the machine to 15 would be for one portion of the current, *via* 5.*e*.14.*o*.3.*c*.12.*m*.1.*a*.10.*u*.17.*i*.8.*t*.15. and for the other portion *via* 5.*g*.16.*h*.7.*s*.18.*k*.9.*n*.2.*b*.11.*p*.4.*d*.13.*r*.6.*g*.15., thus including every coil.

While the term magneto or dynamo electric machines is used herein, both in description and claims, it is evident that these improvements are equally applicable to electric engines or motors, and that the claims herein are to be construed and taken as covering such application.

What is claimed is,—

First. The combination with the brush holder of a magneto or dynamo electric machine, of means for giving an adjustable pressure of the brush upon the commutator, substantially as set forth.

Second. The combination with a commutator of a series of brushes each mounted independently upon a common supporting shaft or bar, and independently adjusted, substantially as set forth.

Third. The combination with a commutator of a series of brushes and holders each mounted independently upon a common bar or shaft, and arranged so that each brush takes obliquely upon the commutator, substantially as set forth.

Fourth. A brush holder formed of two parts, the one for fixed seating upon a proper support, the other connected thereto by an adjustable spring union, substantially as set forth.

Fifth. A magneto or dynamo electric machine consisting of a series (two or more) of independent field of force magnets and a single armature or bobbin common to them all, substantially as set forth.

Sixth. The combination of a magneto or dynamo electric machine, a steam engine connected thereto by a counter balanced connection, a governor, and variable cut off automatically controlled thereby, and an armature or bobbin serving both as an armature or bobbin and as a fly or balance wheel, substantially as set forth.

Seventh. The combination with a common base of an automatically controlled engine, a magneto or dynamo electric machine, and non magnetic supports placed between the generator and the base, substantially as set forth.

Eighth. The combination with the polar extensions of a series of independent electro magnets forming, with a bobbin common to them all, a generator of a non-magnetic plate or brace uniting and supporting the polar extensions, substantially as set forth.

Ninth. The combination of a generator, a high speed steam engine, and a variable cut-off and governor, so that the speed of the engine and the power or pressure of the current are automatically regulated, substantially as set forth.

Tenth. A governor for an electric engine arranged to break the circuit at regular definite intervals, substantially as set forth.

Eleventh. A governor for an electric engine arranged to break the circuit once in every revolution of the governor at a point and for a fraction of the revolution dependent upon the speed of the engine or amount of load, substantially as set forth.

Twelfth. The method of reducing speed between an electric engine and the machinery driven thereby, by first converting the rotary motion of the armature into oscillatory motion, and then reconverting the oscillatory motion into rotary motion, substantially as set forth.

Thirteenth. The combination with the rotary armature of an electric engine of an oscillating pawl carrier and a friction wheel actuated thereby, substantially as set forth.

Fourteenth. The combination of a rotating armature, an oscillating pawl carrier, a pitman, and an adjustable connection, so that the throw and speed of the pawl carrier may be varied, substantially as set forth.

Fifteenth. The combination of a rotating armature, an adjustable double pawl carrier, an adjustable connection between them, and means for determining which pawl shall be kept in operation at any one time, substantially as set forth.

Sixteenth. The combination of an electric engine, a machine driven thereby, and a pitman for connecting the two directly without the intervention of gearing or belts, substantially as set forth.

Seventeenth. The combination of a magneto or dynamo electric machine and an electric engine constructed relatively to each other, so that the engine must run at a much greater speed than the magneto or dynamo electric machine to produce a counter electro-motive force equalling the electro motive force of the dynamo or magneto electric machine, substantially as set forth.

Eighteenth. The combination of a battery of magneto or dynamo electric machines and a battery of electric motors or engines arranged differently relatively to each other, as described, substantially as set forth.

Nineteenth. The method of transferring power into electricity and reconverting the electricity into power, consisting in generating the current in dynamo or magneto electric machines, or in a battery thereof giving a certain speed, a certain electro motive force transmitting the current to an electric engine or motor or series thereof arranged to give the same electro-motive force only at a much higher rate of speed, substantially as set forth.

Twentieth. The combination with the main circuit of a series or battery of magneto or dynamo electric machines used either as generators or receiving machines, of a shunt circuit to the bobbin or armature of one of the machines, which shunt passes around and energizes all the field of force magnets of the battery, substantially as set forth.

Twenty first. The method of generating currents by the use of a water wheel as a prime motor, consisting in using two wheels, the first and larger pumping water to a hight, then using the water so pumped with its greater head to actuate a smaller wheel at a greater rate of speed, the second wheel being connected to the generator, substantially as set forth.

Twenty second. A revolving armature for magneto or dynamo electric machines, having its ends formed of radial plates suitably connected, substantially as set forth.

Twenty third. The combination in an armature for magneto or dynamo electric machines, of radial plates and circular connecting plates, substantially as set forth.

Twenty fourth. The combination with the armature of a magneto or dynamo electric machine provided with a series of coils or bars, of a commutator and connections arranged to retain all the coils constantly in the circuit, substantially as set forth.

Twenty fifth. An armature for dynamo or magneto electric machines having its active or generative portions made of naked bars or ribbons of metal, substantially as set forth.

Twenty sixth. An armature for dynamo or magneto electric machines in which the active or generative portions may be removed without disturbance of the end or inert portions, substantially as set forth.

In witness whereof, I, the said Peter Jensen, have hereunto set my hand and seal, this Twenty second day of March, in the year of our Lord One thousand eight hundred and eighty one.

PETER JENSEN. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1881.

A.D. 1880. Sep. 30. № 3964.
JENSEN'S SPECIFICATION.

(2 SHEETS)
SHEET 1.

FIG. 1.

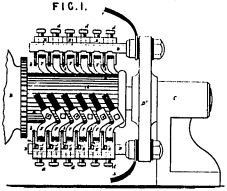
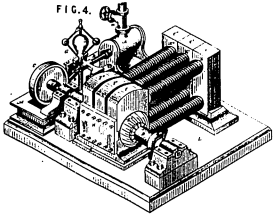


FIG. 2.

FIG. 3.

FIG. 4.



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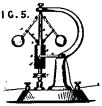

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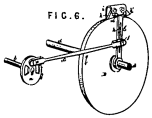
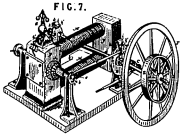


FIG. 7.



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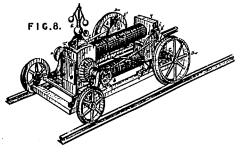

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Printers to the Queen's most Excellent Majesty. 1881

FIG. 9.

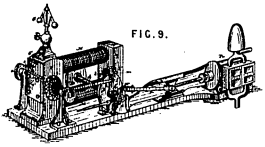


FIG. 10.

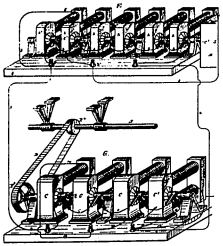
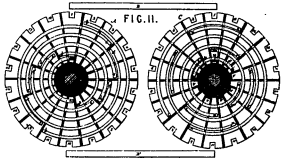


FIG. 11.



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A.D. 1880, 20th OCTOBER. N° 4276.

Separating Impurities from Auriferous Ores, &c.

LETTERS PATENT to Edward Griffith Brewer, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN THE MODE OF AND APPARATUS FOR SEPARATING IMPURITIES FROM AURIFEROUS ORES AND IN THE TREATMENT OF SUCH ORES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Edward Griffith Brewer at the Office of the Commissioners of Patents on the 20th October 1880.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN THE MODE OF AND APPARATUS FOR SEPARATING IMPURITIES FROM AURIFEROUS ORES AND IN THE TREATMENT OF SUCH ORES." (A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.)

By careful microscopic and chemical tests the inventor has found that the gold, or the greater portion thereof, in the so called auriferous sulphurets exists as free gold therein, either comparatively coarse, *i.e.*, in small lumps or flakes, or in a very finely comminuted state, sometimes the surface, but it only being affected by the sulphur, though then sufficiently to prevent easy or economic amalgamation.

The inventor has also found that while sulphuret of iron and ferrous oxide are generally considered to be non-magnetic, they are in fact slightly magnetic, so much so that they may be magnetically affected, especially when subjected at a small distance to the action of powerful magnets, such as may be produced by currents from large magneto or dynamo-electric machines.

With these discoveries as a basis the inventor has devised a process by which the ferrous compounds constituting the greater portion of the "gangue" of the so called auriferous sulphurets may be easily and economically removed from the auriferous portion.

[*Price* 6*d.*]

By microscopic and other tests it is first determined whether the gold be fine or comparatively coarse, that only being called fine when the gold therein is found to be as fine as or finer than the degree of comminution to which it is practicable to reduce the rock or "gangue" by grinding or stamping.

If the gold be found to be coarse the material is simply ground, the iron remaining in the shape of sulphuret of iron.

If the gold be fine the material is roasted and ground, this process changing the sulphuret of iron to ferrous oxide.

The material is then passed through the series of magnetic separators hereinafter referred to.

The magnets therein being of great strength due to the large currents from powerful magneto or dynamo-electro machines used therewith act magnetically upon the iron compounds, drawing them out of the mingled material and leaving the remainder to be treated by some appropriate process in order to free the gold from any impurities which may exist.

The inventor has found that by this course of treatment sulphurets, even when of very low "grade" may be readily and economically treated, and the gold profitably separated therefrom.

The inventor has a device for separating magnetic and non-magnetic substances, consisting essentially of a magnet, past whose poles fall the mingled substances, the attraction of the magnet acting to alter the path of the magnetic substance, drawing it out and away from the non-magnetic portion, the magnetic and non-magnetic substances falling into different receptacles.

Another part of the Invention in this case relates to improvements upon the above described device, and consists in the feature more particularly hereinafter specified. In this Invention V shaped electro magnets are used, made up of one or of several series of coils.

Where several series of coils are used their polar faces or extensions are united to form one polar face or extension for one polarity, the polar face being placed at right angles to the flow of the material to be treated.

The magnetic material is acted on consequently by both poles. As the first draws it out of its path, if the second were in the same plane relatively to the flow of material, it would act on the material at a shorter distance than the first, and would possibly attract the material to itself.

To avoid this it is better to place the active faces of the polar extensions in different planes relatively to the flow of material, the second being placed at the rear of the first, a distance approximately equal to the distance the first draws the magnetic material out of its path.

From the fact that often a particle or particles of magnetic substances are not drawn out of their path sufficiently, and fall with the non magnetic substances it is preferable that the material be subjected to the action of the separator several times in order to ensure thorough separation.

As some portion of the substance to be treated is more magnetic than another, this more magnetic portion is apt to be drawn out of its path and separated by the first separator; moreover if the magnets be too near the path of the very magnetic material they would be apt to draw such material to themselves, which clinging thereto would soon clog the magnets, thus constantly extending their poles; hence the magnets of the first separator are placed at some distance from the path of the material.

In order then to act equally on the less magnetic portion is is preferable that the next set of magnets be placed somewhat nearer the path of the falling material, and so with each successive separator of the series.

To accomplish this several, preferably three, separators are arranged in series, somewhat in echelon, so that the portion which passes into the non-magnetic receptacle of the first passes immediately to the second separator, and so on through

the series, the magnetic receptacles of all the series leading to a common delivery shoot.

Combined with this series is a suitable hopper and sieve and elevator for carrying the sifted material up and delivering it to the first separator of the series.

The construction of the individual separator and the series possesses advantages beyond those noted, especially for use in an improved process of treating so called auriferous sulphurets.

It is evident that the use of a separator thus constructed is not limited to the separation of magnetic substances from auriferous ores, but may be used wherever it is desired to separate mingled magnetic and non-magnetic substances.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Edward Griffith Brewer in the Great Seal Patent Office on the 20th April 1881.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN THE MODE OF AND APPARATUS FOR SEPARATING IMPURITIES FROM AURIFEROUS ORES AND IN THE TREATMENT OF SUCH ORES." (A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.)

By careful microscopic and chemical tests the inventor has found that the gold, or the greater portion thereof, in the so-called auriferous sulphurets exists as free gold therein, either comparatively coarse, *i.e.*, in small lumps or flakes, or in a very finely comminuted state sometimes the surface, but it only being affected by the sulphur, though then sufficiently to prevent easy or economic amalgamation.

The inventor has also found that while sulphuret of iron and ferrous oxide are generally considered to be non-magnetic, they are in fact slightly magnetic, so much so that they may be magnetically affected, especially when subjected at a small distance to the action of powerful magnets, such as may be produced by currents from large magnets or dynamo-electric machines.

With these discoveries as a basis the inventor has devised a process by which the ferrous compounds constituting the greater portion of the "gangue" of the so-called auriferous sulphurets may be easily and economically removed from the auriferous portion.

By microscopic and other tests it is first determined whether the gold be fine or comparatively coarse, that only being called fine when the gold therein is found to be as fine as or finer than the degree of comminution to which it is practicable to reduce the rock or "gangue" by grinding or stamping.

If the gold be found to be coarse the material is simply ground, the iron remaining in the shape of sulphuret of iron.

If the gold be fine the material is roasted and ground, this process changing the sulphuret of iron to a ferrous oxide.

The material is then passed through the series of magnetic separaters hereinafter referred to.

The magnets therein being of great strength, due to the large currents from powerful magneto or dynamo electric machines used therewith, act magnetically upon the iron compounds, drawing them out of the mingled material and leaving the remainder to be treated by some appropriate process in order to free the gold from any impurities which may exist.

The inventor has found that by this course of treatment sulphurets, even when of very low grades, may be readily and economically treated, and the gold profitably separated therefrom.

The inventor has a device for separating magnetic and non-magnetic substances, consisting essentially of a magnet, past whose poles fall the mingled substances, the attraction of the magnet acting to alter the path of the magnetic substance, drawing it out and away from the non-magnetic portion, the magnetic and non-magnetic substances falling into different receptacles.

Another part of the Invention in this case relates to improvements upon the above described device, and consists in the features more particularly hereinafter specified.

In this Invention U shaped electro magnets are used, made up of one or of several series of coils.

Where several series of coils are used, their polar faces or extensions are united to form one polar face or extension for one polarity, the polar face being placed at right angles to the flow of the material to be treated.

The magnetic material is acted on consequently by both poles. As the first draws it out of its path, if the second were in the same plane relatively to the flow of material, it would act on the material at a shorter distance than the first, and would possibly attract the material to itself.

To avoid this it is better to place the active faces of the polar extensions in different planes relatively to the flow of material, the second being placed at the rear of the first, a distance approximately equal to the distance the first draws the magnetic material out of its path.

From the fact that often a particle or particles of magnetic substances are not drawn out of their path sufficiently and fall with the non-magnetic substances, it is preferable that the material be subjected to the action of the separator several times in order to insure thorough separation.

As some portion of the substance to be treated is more magnetic than another, this more magnetic portion is apt to be drawn out of its path and separated by the first separator; moreover if the magnets be too near the path of the very magnetic material they would be apt to draw such material to themselves, which clinging thereto would soon clog the magnets, thereby constantly extending their poles; hence the magnets of the first separator are placed at some distance from the path of the material.

In order then to act equally on the less magnetic portion, it is preferable that the next set of magnets be placed somewhat nearer the path of the falling material, and so with each successive separator of the series.

To accomplish this several, preferably three, separators are arranged in series, somewhat in echelon, so that the portion which passes into the non-magnetic receptacle of the first passes immediately to the second separator, and so on through the series, the magnetic receptacles of all the series leading to a common delivery shoot.

Combined with this series is a suitable hopper and sieve and elevator for carrying the sifted material up and delivering it to the first separator of the series.

The construction of the individual separator and the series possesses advantages beyond those noted, especially for use in an improved process of treating so-called auriferous sulphurets, which forms a portion of this Invention.

It is evident that the use of a separator thus constructed is not limited to the separation of magnetic substances from auriferous ores, but may be used wherever it is desired to separate mingled magnetic and non-magnetic substances.

Such part of the Invention as is capable of illustration is shewn in the accompanying Drawings, in which

Figure 1 represents in perspective view a series of separators and accessories mounted in a suitable framing.

Figure 2, a single hopper and magnet in detail; Figure 3, a series of magnetic separators in section taken on line *x*, *x*, of Figure 1.

H, H, H, shews the framing, which may be of any suitable kind, in which are secured the separators 1, 2, 3, each consisting essentially of a hopper and magnet, as A M, B M^1, and C M^2.

The material to be treated is first fed into a hopper F, whence it passes into a sieve, as all lumps, stones, &c., should be separated from the material to be treated.

An elevator L conveys the material to the hopper A of the first separator, whence it falls in front of the magnet M.

Below M is a hopper B receiving the non-magnetic portion and passing it before the second magnet M^1, the magnetic portion falling into B^1, and thence into the waste shoot E.

Below M^1 is a similar hopper C passing the non-magnetic material before M^2, and the passage C^1 passing the magnetic portion into the waste shoot E.

This construction and relation are repeated until as many separators as may be desired are arranged in the series.

Brewer's Apparatus for Separating Impurities from Auriferous Ores, &c.

It will be noticed that each succeeding magnet is set nearer the path of the material than its predecessor in the series; for instance, M^{11} is nearer such path than M^{1}, and M^{1} than M.

Motion is communicated to various portions of the series by means of belts and the pulleys P, P, *etc.*

When desired it is evident that the elevator may be dispensed with, and the sifted material be conveyed to the hopper of the first separator in any convenient manner.

Having now described the nature of the said Invention and in what manner the same is to be performed I declare I claim,—

First. In an electro magnetic separator, a magnet, a series of magnets whose poles or polar extensions or faces are in different planes relatively to the path of the material to be treated, substantially as set forth.

Second. The combination of a series of magnetic separators, substantially such as described, arranged to act successively upon the same stream of material, substantially as set forth.

Third. The combination of a series of magnetic separators, substantially such as described, each one of the series being arranged nearer the path of the material to be acted on than its predecessor in the series, substantially as set forth.

Fourth. The combination with a series of magnetic separators arranged to act consecutively upon a stream of material of a single waste shoot and a passage thereto from each separator, substantially as set forth.

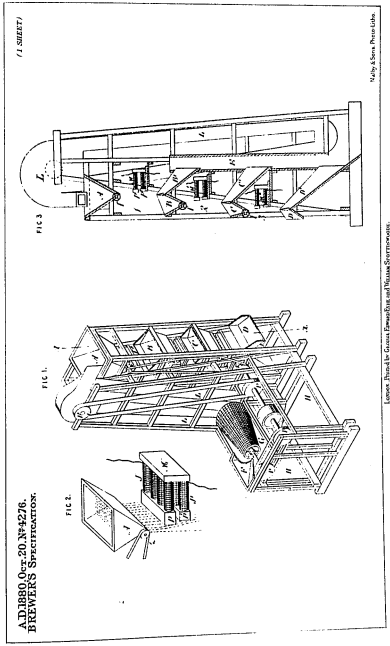
Fifth. The combination of a sieve, an elevator, a series of separators, and a single waste shoot, substantially as set forth.

Sixth. The method of treating so-called auriferous sulphurets, which consist in reducing them to powder and then subjecting the resulting material (either raw or roasted) to the action of a magnetic separator, substantially as set forth.

In witness whereof, I, the said Edward Griffith Brewer, have hereunto set my hand and seal, this Sixteenth day of April, in the year of our Lord One thousand eight hundred and eighty one.

E. G. BREWER. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1881.



A.D. 1880, 27th October. N° 4391.

Measuring the Amount of Electrical Current Flowing through a Circuit.

LETTERS PATENT to Peter Jensen, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "Improvements in Means for Measuring the Amount of Electrical Current Flowing through a Circuit." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Peter Jensen at the Office of the Commissioners of Patents on the 27th October 1880.

Peter Jensen, of 33, Chancery Lane, in the County of Middlesex. "Improvements in Means for Measuring the Amount of Electrical Current Flowing through a Circuit." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

In any system of furnishing to consumers electricity for light, power, or other purposes, it is desirable that means be provided which shall accurately measure the current used.

It is also desirable that this measure of current should be automatically indicated and registered in a manner analogous to the registration of gas or water flow.

The object of this Invention is to furnish means for attaining these results, to which end it consists, broadly speaking, in using balanced plates in a depositing cell so arranged in connection with other devices that the deposition of metal upon one plate causes an overbalancing, which sets in operation registering devices and devices reversing the circuit through the cell.

In practice devices, combinations, and circuits, somewhat as follows, are used:—

A depositing cell is used in which the plates are suspended but insulated from a balanced arm, to which is attached a lever arm, on which is a weight adjustable on a lever arm, so that the amount of excess of weight upon one plate over the

[*Price* 6*d*.]

other required to cause a tilting of the balanced arm may be determined and regulated.

The cell so arranged is placed in a branch circuit, that is, a circuit derived from one member of the circuit supplying electricity to the translating devices containing a resistance, being so arranged that a definite fraction of the current used shall traverse the branch circuit and depositing cell.

It is evident then that as the weight of one plate is increased by the deposition of, say, copper from the solution, it will tip the balanced arm whenever the weight of the increase becomes sufficient to overbalance the weight alluded to as on the lever arm.

The lever arm moving causes a movement of a registering apparatus registering each tip, and at the same time causes a reversal of the current through the cell, the effect of which is that the copper is absorbed or removed from the now heavier plate and deposited upon the lighter, until it in turn becomes the heavier, causing another tipping, another registration, and another reversal.

As the amount of current needed to cause the deposition of metal enough to cause the tipping is known, and as it is a definite percentage of the entire current, the registration may indicate the total amount of current; or as the ratio existing between current and feet of gas for illuminating effect has been determined, the registration may indicate the equivalency in light of feet of gas.

As stated the tipping of the balanced arm and attached lever arm causes a movement of a registering apparatus and a reversal of the current through the depositing cell.

It may cause this directly by having either the balanced or the lever arm connected directly to a register and to a reverser, or indirectly by setting into operation intermediate mechanism.

In the latter case the following is a convenient arrangement:—

Two magnets are used with their poles placed oppositely, between which plays an armature lever, one end of which is attached to prime motor of the register, the other end playing in the open part of a fork or **Y**, whose upper ends operate a reverser.

The play of the **Y** is limited by two set screws, one on either side, with a circuit connection from each to one of the magnets, the connection from the left hand screw being to the right hand magnet, and from the right hand screw to the left hand magnet.

The play of the weighted lever arm before referred to is determined by two set screws, each screw being connected with the magnet upon its side.

From one member of the circuit containing translation devices is a circuit connection to the **Y** while the lever arm is connected to the other member. In this circuit is interposed a very large resistance, so that but a small percentage of the current passes therethrough, simply enough to operate an ordinary electro magnet.

A circuit then may be formed through either magnet, in which are two breaks, one closed by the weighted lever at the end of its movement, the other by the **Y** at the end of its movement, the circuit being shifted from one magnet to the other as the lever arm is tipped by one plate receiving its determined load by deposition.

Around each magnet is a short circuit of large resistance, which affords a path for the extra or induced current, avoiding spark therefrom at the contact points.

The same principle, namely, the effecting of a registration by the over weighting of a plate by deposition may also be carried into effect by mounting upon a shaft a series of plates which radiate therefrom. This shaft is journaled in a suitable case, which is filled with the proper depositing solution nearly up to the shaft.

Upon the shaft are a series of commutator blocks one for each plate.

Commutator springs are so arranged as to bear simultaneously upon the blocks of the plates remote from each other in the fluid, a branch circuit from one member of the consumption circuit being connected to the springs.

As deposition proceeds one plate becomes so loaded as to cause a partial rotation of the shaft, which causes the circuit to be formed through another plate, which, becoming loaded, causes further rotation, bringing another plate into the circuit, whereupon the first plate is again in circuit, but in such relation as to be the plate which is reduced to afford material for deposition upon the other plate in circuit, each plate being thus successively loaded and stripped, the movement from one plate to the other causing by loading by deposition being registered by the rotation of the shaft.

The Invention may be carried into effect in many other ways, but the ones here described are sufficient to illustrate its principle.

Instead of a balanced arm from which the plates are suspended a spring balance may be used, the plate as it becomes loaded acting on a spring to make the necessary circuit connections at the predetermined point.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Peter Jensen in the Great Seal Patent Office on the 27th April 1881.

PETER JENSEN, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN MEANS FOR MEASURING THE AMOUNT OF ELECTRICAL CURRENT FLOWING THROUGH A CIRCUIT." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

In any system of furnishing to consumers electricity for light, power, or other purposes, it is desirable that means be provided which shall accurately measure the current used. It is also desirable that this measure of current should be automatically indicated and registered in a manner analogous to the registration of gas or water flow.

The object of this Invention is to provide means for attaining these results, to which end it consists, broadly speaking, in using balanced plates in a depositing cell, so arranged in connection with other devices that the deposition of metal upon one plate causes an overbalancing, which sets in operation registering devices and devices reversing the circuit through the cell. In practice devices, combinations, and circuits somewhat as follows are used:—

A depositing cell is used in which the plates are suspended but insulated from a balanced arm, to which is attached a lever-arm, on which is a weight adjustable on a lever-arm, so that the amount of excess of weight upon one plate over the other required to cause a tilting of the balanced arm may be determined and regulated.

The cell, so arranged, is placed in a branch circuit, that is, a circuit derived from one member of the circuit supplying electricity to the translating devices containing a resistance so arranged that a definite fraction of the current used shall traverse the branch circuit and depositing cell.

It is evident, then, that as the weight of one plate is increased by the deposit of, say, copper from the solution, it will tip the balanced arm whenever the weight of the increase becomes sufficient to overbalance the weight alluded to as on the lever arm.

The lever-arm moving causes a movement of a registering apparatus registering each tip, and at the same time causes a reversal of the current through the cell, the effect of which is that the copper is absorbed or removed from the now heavier plate and deposited upon the lighter, until it in turn becomes the heavier, causing another tipping, another registration, and another reversal. As the amount of current needed to cause the deposition of metal enough to cause the tipping is known, and as it is a definite percentage of the entire current, the registration may indicate the total amount of current; or as the ratio existing between current and feet of gas for illuminating effect has been determined, the registration may indicate the equivalency in light of feet of gas.

As stated, the tipping of the balanced arm and attached lever-arm causes a movement of the registering apparatus and a reversal of the current through the depositing cell. It may cause this directly by having either the balanced or the lever-arm connected directly to a register and to a reverser, or indirectly by setting into operation intermediate mechanism. In the latter case the following is a convenient arrangement:—

Two magnets are used with their poles placed oppositely, between which plays an armature lever, one end of which is attached to the prime motor of the register,

the other end playing in the open part of a fork or Y, whose upper end operate a reverser.

The play of the Y is limited by two set screws, one on either side, with a circuit connection from each to one of the magnets, the connection from the left hand screw being to the right hand magnet and from the right hand screw to the left hand magnet. The play of the weighted lever arm before referred to is determined by two set screws, each screw being connected with the magnet upon its side. From one member of the circuit containing translation devices is a circuit connection to the Y, while the lever arm is connected to the other member. In this circuit is interposed a very large resistance, so that but a small percentage of the current passes therethrough, simply enough to operate an ordinary electro-magnet.

A circuit then may be formed through either magnet, in which are two breaks, one closed by the weighted lever at the end of its movement, the other by the Y at the end of its movement, the circuit being shifted from one magnet to the other as the lever-arm is tipped by one plate receiving its determined load by deposition.

Around each magnet is a short circuit of large resistance, which affords a path for the extra or induced current, avoiding spark therefrom at the contact points.

The same principle, namely, the effecting of a registration by the over weighting of a plate by deposition, may also be carried into effect by mounting upon a shaft a series of plates which radiate therefrom. This shaft is journalled in a suitable case, which is filled with the proper depositing solution nearly up to the shaft. Upon the shaft are a series of commutator blocks, one for each plate. Commutator springs are so arranged as to bear simultaneously upon the blocks of the plates remote from each other in the fluid, a branch circuit from one member of the consumption circuit being connected to the springs. As deposition proceeds one plate becomes so loaded as to cause a partial rotation of the shaft, which causes the circuit to be formed through another plate, which, becoming loaded, causes further rotation, bringing another plate into the circuit, whereupon the first plate is again in circuit, but in such relation as to be the plate which is reduced to afford material for deposition upon the other plate in circuit, each plate being thus successively loaded and stripped, the movement from one pole to the other causing by loading by deposition, being registered by the rotation of the shaft.

The Invention may be carried into effect in many other ways, but the ones here described are sufficient to illustrate its principle.

Instead of a balanced arm from which the plates are suspended a spring balance may be used, the plate as it becomes loaded acting on a spring to make the necessary circuit connections at the pre-determined point.

In the Drawings,

Fig. 1 is a view, partly perspective, partly plan, showing the form first described, while

Fig. 2 is the second plan or modification.

In Figure 1 A is any suitable containing cell provided with a cover B, upon which is a balanced arm *a* attached to a shaft *b* pivoted in suitable bearings or supports attached to the cover.

From the ends of the arm *a* are suspended the plates C, C', forming the anode and cathode of the cell. Upon the end of *b* is a lever-arm *d*, upon which slides the weight d^1 provided with means for securing it at any desired position. At its lower or free end *d* is provided with contact points which take against the set screws S, O, which limit its motion.

E, E', are two electro-magnets whose poles face each other, acting upon armatures upon a lever F pivoted at *k* playing between the two magnets, and so connected at its lower end with a register H, so as to operate it upon each vibration of the armature lever. At its upper end F takes between the limbs of the fork D pivoted at *i*, to whose upper end is attached an arm *g* taking between contact springs or levers *f*, f^1, which in connection with *c* form a reverser. *h* is a small spring

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having a projection at its end taking over a small projection upon D with sufficient force to hold it against accidental displacement.

1, 2, are the main conductors of a system from which lead conductors 15, 16, to and through the place of consumption. From 15 a circuit is formed through the depositing cell by 11. g. f^1. 12. C. C^1. 13. f. e. 14. the direction of the current in 5 the cell being determined by the contact of f, f^1, and e, in the reverser. Between 11 and 14 in 15 a resistance R^1 is placed, adjusted to cause a definite and determined fraction of the entire current traversing 15 to pass through the cell.

A circuit for the magnets E, E^1, is formed as a derived or multiple arc circuit to 15, 16, by 15, 3, D, and then in one position of D by l. 4. E^1. 5. 9. d. 10. 16. or 10 in another position of D, by 15. 3. D. l^1. E. 6. 7. 8. d. 10. 16. In 10 a resistance R is placed adjusted to the resistance of the main circuit, so that only a small amount of current, simply enough to make E or E^1 effective, shall traverse the circuit through them. Short circuits around E, E^1, are formed containing resistances r, r^1, for the purpose of absorbing the extra or induced current, lessening or avoiding 15 spark at the contact points. The operation is as follows:—Suppose the parts to be in the position shown in Figure 1, and the current flowing through the cell so that C is the anode and C^1 the cathode. As metal is deposited upon C^1 it gradually overbalances C, swinging d out of the perpendicular until finally it takes against screw 9, whereupon the circuit through E^1 is closed, *via* 10. d. 9. 5. 4. l. D. 3. 20 E^1 attracts F^1, causing it to operate the register 11; E in moving toward E^1 strikes D, causing it to break circuit at l and carrying it over against l^1; at the same time the arm g is carried in the reverse direction, leaving f^1 and allowing it to contact with e, and at the same time contacting with f and causing it to break contact with e, causing the current to pass through the cell in the 25 reverse direction. C^1 now becomes the anode, and the metal deposited thereon is dissolved therefrom and carried to C, which finally becomes the heavier, causes a repetition of the operations described. It is evident that the reverser and register might be actuated directly by d, but the devices shown are more accurate and delicate, and destructive sparks at the contacts are greatly lessened if not 30 entirely obviated. In Fig. 2, K is any suitable case, in which rotates a shaft from which project radial plates n. o. p. *etc.*, dipping into the fluid o. The plates are insulated from each other, and each is attached to a commutator block; m, m^1, are commutator brushes or springs arranged to bear upon the blocks of the plates remote from each other in the fluid. To m, m^1, lead conductors 19, 20, 35 completing a branch circuit from the house or consumption circuit. Suppose the current to flow in such direction that n is the anode and p is the cathode, as p becomes loaded it sinks in the fluid causing it to rotate, which movement is registered upon a register attached thereto. This movement has brought o in contact with m, making it the anode, and r in contact with m^1, making it the 40 cathode. When r becomes loaded it causes a rotation, when p becomes the anode and s the cathode, whereupon the metal formerly deposited thereon is dissolved off.

In both forms each plate is alternately an anode and a cathode, receiving a deposit only to have it stripped off, the very act of deposition setting in operation 45 agencies which cause the change from anode to cathode, and agencies which register the change.

The register H may be made so as to indicate vebers or current units, or as the relation between current and gas for light production is known, it may indicate the number of feet of gas which would be equivalent in light production to the 50 amount of current registered.

While these devices are shown in a branch circuit so that only a portion of the current passes therethrough, it is evident that they may be placed directly in the circuit.

While the circuits controling the mechanical devices are here shown as branch or 55 multiple arc circuits, it is evident that they may be battery local circuts.

Jensen's Impts. in Measuring the Electrical Current Flowing through a Circuit.

It is also evident that all the mechanical devices may be actuated by clock-work which is controlled by the balanced arm or lever.

As this arrangement registers the exact number of vebers or current units passing therethrough, the name of "vebermeter" has been applied to it.

What is claimed is,—

First. An electro-depositing cell in which each plate becomes alternately anode and cathode, substantially as set forth.

Second. The method of measuring a current of electricity, consisting in causing a definite portion to pass through a depositing cell containing balanced plate or plates, the overbalancing of the plates causing a registration and a change of the anode and cathode relation of the plates successively, substantially as set forth.

Third. The combination of a decomposing cell, balanced polar plates therein, and a registering apparatus controlled by the overlonding of either plate, substantially as set forth.

Fourth. The combination of a decomposing cell, balanced polar plates therein, and a reverser reversing the direction of the current through the cell, and controlled by the overlonding of either plate, substantially as set forth.

Fifth. The combination of a decomposing cell, balanced polar plates therein, and registering apparatus and means for reversing the direction of the current through the cell, the register and reverser being controlled by the overlonding of either plate, substantially as set forth.

Sixth. The combination with two magnets of a common armature lever playing between them and a contact device operated by the lever, the lever on its attraction by either magnet causing a break in the circuit of the magnet attracting it and closing a break in the circuit of the other magnet.

Seventh. The combination with an armature lever playing between two magnets and operating as described, of a reverser actuated by the armature lever on its movement in either direction, substantially as set forth.

In witness whereof, I, the said Peter Jensen, have hereunto set my hand and seal, this Twentysixth day of April, in the year of our Lord One thousand eight hundred and eightyone.

PETER JENSEN. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1881.

A.D.1880. Oct. 27. № 4391.
JENSEN'S SPECIFICATION.

(1 SHEET)

FIG. 1.

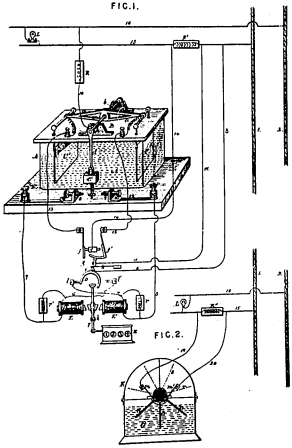


FIG. 2.

Malby & Sons, Photo-Lith.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1881.

A.D. 1880, 10th *November*. N° 4621.

Magneto-electric Signal Apparatus.

LETTERS PATENT to Edward Griffith Brewer, of 33, Chancery Lane, in the County of Middlesex, for an Invention of "IMPROVEMENTS IN MAGNETO ELECTRIC SIGNAL APPARATUS." A communication from abroad by Edward Hibberd Johnson and Thomas Alva Edison, both of Menlo Park, in the State of New Jersey, United States of America.

PROVISIONAL SPECIFICATION left by the said Edward Griffith Brewer at the Office of the Commissioners of Patents on the 10th November 1880.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN MAGNETO ELECTRIC SIGNAL APPARATUS." (A communication from abroad by Edward Hibberd Johnson and Thomas Alva Edison, both of Menlo Park, in the State of New Jersey, United States of America.)

Magneto electric machines, as signal apparatus, are often used in such relation to other devices that it is desirable that they should be cut out of circuit when not in use, being thrown into circuit only when in use.

It is also often desirable that they should, without any change at the time of use, be capable of giving two distinct signals, as for instance, a continuous ring and an intermittent ring, indicating two distinct wants, or operations, or things.

The accomplishment of both these results in one organization is the object of this Invention.

In carrying the Invention into effect a shunt circuits is formed around the magneto machine or generator, connected to the main circuit upon each side of the generator, a portion of which circuit is a contact spring or lever taking against an anvil or contact point.

The actuating handle or pulley is attached to a sleeve which is loose upon the main driving shaft, but secured thereto by a pin on the shaft taking in a triangular opening or slot in the side of the sleeve.

Upon the inner end of the sleeve is a disc which takes against a rod whose other end bears against the contact spring or lever.

The force of the contact spring, or that of a special spring, is used to nominally hold the rod pushed against the disc, so that the sleeve is as far out on the shaft as the slot and pin permit, in which condition the spring impinges on the anvil or

[*Price* 6*d*.]

contact point, closing the shunt circuit, thus practically cutting the generator out of circuit.

Upon rotation, the sleeve turns loosely upon the shaft until the outer end of the slot reaches the pin, when sleeve and shaft turn together. The slot being triangular, causes the carrying inward of the sleeve and disc, pushing the rod against the contact lever or spring, causing it to leave the contact point or anvil, breaking thereby the shunt or short circuit, compelling the current from the generator to traverse the main circuit.

Upon cessation of use the parts return to their normal position, closing the shunt or short circuit.

By the arrangement thus described, the first of the objects noted is accomplished.

To accomplish the second object the arrangement noted is modified as follows:—

The contact spring referred to is made with a twist about its centre so as to be capable of motion in either direction.

To it is attached directly the pin which takes against the disc upon the sleeve.

In the inner face of the disc a groove is cut extending partly around the disc, and whose outer edge normally is out of the path of the pin.

One end of this groove is broadened somewhat by its outer edge being carried by an easy curve into the path of the pin.

At both ends the descent from the face of the disc to the bottom of the groove is by an incline, so that the pin may enter or emerge from the groove without jar.

As before stated, the groove extends only partially around the face of the disc, leaving a "land" of the normal plane of the disc between the ends of the groove.

If the sleeve be turned in the direction of the narrow end of the groove the pin takes against the face of the disc outside of the groove, and is simply pressed in, breaking the shunt circuit as before explained, causing a continuous wave of current to be sent upon the line, and a continuous signal to be made, say, a continuous ringing of a bell.

If, however, the sleeve be turned in the opposite direction, the pin is hit by the outer edge of the broadened end of the groove and carried inward slightly, the pin taking in the groove, leaving the shunt closed so long as the pin is in the groove, the pin being forced inward, and the shunt consequently broken, only when the pin passes out of the groove and rides upon the land.

By this means the current is sent upon the line during a part of each revolution only, with the result that an intermittent signal, or a signal composed of sounds with intervening pauses is given.

In the bottom of the groove referred to could be made a series of inclined or cam faces following each other in any desired sequence so that a regular dot and dash or any other arbitrary signal could be given.

This arrangement permits of two distinct signals being given without change of apparatus, or any operation on the part of the operator, except the mere change of direction of rotation.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Edward Griffith Brewer in the Great Seal Patent Office on the 10th May 1881.

EDWARD GRIFFITH BREWER, of 33, Chancery Lane, in the County of Middlesex. "IMPROVEMENTS IN MAGNETO-ELECTRIC SIGNAL APPARATUS." (A communication from abroad by Edward Hibberd Johnson and Thomas Alva Edison, both of Menlo Park, in the State of New Jersey, United States of America.)

Magneto-electric machines as signal apparatuses are often used in such relation to other devices that it is desirable that they should be cut out of circuit when not in use, being thrown into the circuit only when in use.

It is also often desirable that they should, without any change at the time of use, be capable of giving two distinct signals, as, for instance, a continuous ring and an intermittent ring, indicating two distinct wants, or operations, or things.

The accomplishment of both these results in one organization is the object of this Invention.

In carrying the Invention into effect a shunt circuit is formed around the magneto machine or generator, a portion of which circuit is a contact spring or lever taking against an anvil or contact point.

The actuating handle or pulley is attached to a sleeve which is loose upon the main driving shaft, but secured thereto by a pin on the shaft, taking in a triangular opening or slot in the side of the sleeve.

Upon the inner end of the sleeve is a disc which takes against a rod, whose other end bears against the contact spring or lever.

The force of the contact spring, or that of a special spring, is used to normally hold the rod pushed against the disc, so that the sleeve is as far out on the shaft as the slot and pin permit, in which condition the spring impinges on the anvil or contact point, closing the shunt circuit, thus practically cutting the generator out of circuit.

Upon rotation the sleeve turns loosely upon the shaft until the outer end of the slot reaches the pin, when sleeve and shaft turn together; the slot being triangular causes the carrying inward of the sleeve and disc, pushing the rod against the contact lever, or spring, causing it to leave the contact point or anvil, breaking thereby the shunt or short circuit, compelling the current from the generator to traverse the main circuit.

Upon cessation of use, the parts return to their normal position, closing the shunt or short circuit.

By the arrangement thus described the first of the objects noted is accomplished.

To accomplish the second object the arrangement noted is modified as follows:—

The contact spring referred to is made with a twist about its centre, so as to be capable of motion in either direction.

To it is attached directly the pin which takes against the disc upon the sleeve.

In the inner face of the disc a groove is cut extending partly around the disc, and whose outer edge normally is out of the path of the pin.

One end of this groove is broadened somewhat by its outer edge being carried by an easy curve into the path of the pin.

At both ends the descent from the face of the disc to the bottom of the groove is by an incline, so that the pin may enter or emerge from the groove without jar.

As before stated, the groove extends only partially around the face of the disc, leaving a "land" of the normal plane of the disc between the ends of the groove.

If the sleeve be turned in the direction of the narrow end of the groove, the pin

takes against the face of the disc outside of the groove, and is simply pressed in breaking the shunt circuit, as before explained, causing continuous waves of current to be sent upon the line, and a continuous signal to be made, say, a continuous ringing of a bell.

If, however, the sleeve be turned in the opposite direction the pin is hit by the outer edge of the broadened end of the groove and carried inward slightly, the pin taking in the groove, leaving the shunt closed so long as the pin is in the groove, the pin being forced inward, and the shunt consequently broken, only when the pin passes out of the groove and rides upon the "land."

By this means the current is sent upon the line during part of each revolution only, with the result that an intermittent signal or a signal composed of sounds with intervening pauses is given.

In the bottom of the groove referred to could be made a series of inclined or cam faces following each other in any desired sequence, so that a regular dot and dash, or any other arbitrary signal could be given.

This arrangement permits of two distinct signals being given without change of apparatus or any operation on the part of the operator except the mere change of direction of rotation.

The accompanying Drawings fully illustrate how the Invention is carried into effect.

Figure 1 is a plan view, partly in section, of an apparatus embodying the Invention.

Figure 2 is a part side view, and

Figures 3, 4, and 5 are views of details.

A is a magneto machine with field magnets *a*, *a*, between whose polar extensions rotates the armature B, and which is provided with commutators I, I', from which lead the wires 1, 2, of the main circuit.

This magneto machine may be of any desired description, the one here represented being used simply as a type of that class of machines.

C is the main driving shaft connected to the shaft of the armature B by gearing, although it is evident that the shaft C may be the shaft of the armature.

Upon the shaft C is the loose sleeve S, to which is attached the handle H, or a pulley, or other equivalent may be substituted for the handle.

In the side of the sleeve S is the recess or slot *d*, in which takes the pin *e*, secured in shaft C, uniting the shaft and sleeve, but allowing a limited motion of the sleeve upon the shaft determined by the size of the recess.

Upon the inner end of the sleeve is the disc D, in whose inner face is the groove *b* extending partially around the disc, as more clearly shown in Figures 3 and 4. As shewn, one end *b'* of the groove is wider than the other end *c*, the widening being effected by a curving outward of the outer edge of the groove. At both ends the bottom of the groove comes up to the "land" L between the ends of the groove by a gradual incline.

The disc D takes against the pin *i*, on spring E, a part *f* of which normally makes contact with the contact point or anvil F.

The pin *i* passes through a slab *m* in the side of the box or framing.

The spring E is twisted at *x*, so that its flat surface lies in two planes at right angles to each other, but having a common axis, so that it has a movement in two directions.

A shunt circuit is formed by conductors 3 and 4, 3 from 1 to the anvil F, and 4 from 2 to the spring E.

Normally the parts are in the position shewn in Figures 1, 2, and 3, the stress of spring E acting through pin *i*, forcing the sleeve outward, and keeping closed the shunt circuit F, *f*, Figure 1.

If now the sleeve be turned in the direction of arrow 2, Figure 3, the sleeve at first turns loosely on the shaft C, but the pin *e* taking against the inclined face of the opening *d*, causes it to move inward, forcing back the pin *i* and spring F, breaking the shunt circuit.

The shaft and sleeve then move together, and as the pin *i* takes upon the plane of the disc outside of the groove, the shunt circuit is kept broken and a continuous current is sent, which may be utilized for a continuous signal call or other purpose.

If however the sleeve be turned in the direction of arrow 1, Figure 3, the pin *i* is caught by the enlarged end *b'* of the groove, and remains in the groove during a part of the rotation.

During such part the shunt is not broken, and no current goes to line.

As the pin rises up out of the groove and passes over the "land" L the shunt is broken during the time of its passage over such "land," and a current is sent to line.

Thus during each revolution of the disc there is a period of current and a period of no current, so that the signal given is intermittent or broken up.

Figure 5 is a diagram representation of a groove straightened out. In the bottom of the groove inclines or cam surfaces *o*, *o*, could be made in such order, sequence, or relation to each other, as might be desired, so that a definite number, letter, or other arbitrary signal could be given.

While in this arrangement the sleeve is shown as mounted upon the main driving shaft, it is evident that it need not always be placed thereon, but that it may be mounted upon any other shaft or on a special shaft driven from the main driving shaft.

Having now described the nature of the said Invention, and in what manner the same is to be performed, I declare that I claim,—

First. The combination with a main circuit and a magneto-electric machine of a shunt or short circuit around the machine, and means for automatically controlling, upon the operation of the machine, the shunt or short circuit, substantially as set forth.

Second. The combination of the driving shaft of a magneto-electric machine, a sleeve mounted thereon in such manner as to have a determinate longitudinal movement thereon, and a circuit breaker automatically operated by the longitudinal movement of the sleeve, substantially as set forth.

Third. The combination with a magneto machine and its main current of a shunt or short circuit, and means for automatically breaking such short circuit entirely upon movement in one direction and intermittently breaking it upon movement in the other direction, substantially as set forth.

Fourth. The combination of the driving shaft of a magneto electric machine, a sleeve mounted thereon in such manner as to have a determinate longitudinal movement thereon, and a circuit breaker automatically operated by such sleeve to break a current entirely during movement in one direction and intermittently during movement in the other direction, substantially as set forth.

Fifth. The combination with a magneto machine of means, substantially such as described, for producing different signals upon rotation of the driving shaft in different directions, substantially as set forth.

In witness whereof, I, the said Edward Griffith Brewer, have hereunto set my hand and seal, this Seventh day of May, in the year of our Lord One thousand eight hundred and eighty one.

E. G. BREWER. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1881.

A.D.1880, Nov.10.№4621.
BREWER'S SPECIFICATION.

(1 SHEET)

FIG.1

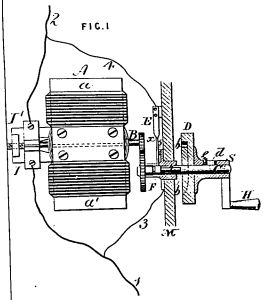


FIG.3.

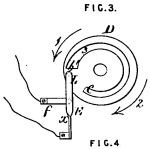


FIG.4

FIG 2.

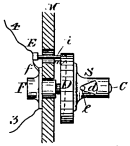


FIG.5

Malby & Sons, Photo-Lith.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1881.

A.D. 1880, 8th DECEMBER. N° 5113.

Telephones.

LETTERS PATENT to Joseph Bond Morgan, of Coleman Street, in the City of London, for an Invention of "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

PROVISIONAL SPECIFICATION left by the said Joseph Bond Morgan at the Office of the Commissioners of Patents on the 8th December 1880.

JOSEPH BOND MORGAN, of Coleman Street, in the City of London. "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, in the United States of America.

This Invention relates chiefly to improvements upon the carbon telephone in respect of which Letters Patent were granted to the said Thomas A. Edison, dated the Thirtieth July, One thousand eight hundred and seventy seven, No. 2900, and Fifteenth June, One thousand eight hundred and seventy eight, No. 2296.

According to one mode of carrying out this Invention a carbon button is secured to the diaphragm of the telephone, and a weight is employed with a platinized screw passing through it and resting upon the carbon button.

Bow springs bearing upon the weight and attached to the carbon button serve to hold the weight in position. The amount of initial pressure may be regulated by the screw. The circuit wires are connected to the primary coil of an inductorium with battery in circuit. Owing to the inertia of the weight, and its not being able to follow very rapid movements of the diaphragm, there results a difference of pressure between the screw and the carbon.

The screw may also be tipped with carbon; in fact several thin wafers of carbon may be used, or a disc or piece of any shape may be used. The weight may be round, square, half round, oblong, oval, or in any configuration so long as it is a weight. It may be a hollow sphere cube, or other shape, and be filled with mercury or any other heavy substance.

The springs may be broad or narrow, and may be bent in any shape between the weight and disc upon the diaphragm.

[*Price* 6*d*.]

In some cases two pieces of carbon or other finely divided conducting matter are secured to the diaphragm, each carbon being connected to the circuit. When in a state of rest the two ends are in contact with each other.

The amount of initial pressure being regulated by the bowing outwardly the diaphragm by a spring at the outside thereof acted upon by a screw, or, two flat carbons may be employed screwed to the diaphragm and adjusted so that the ends are in contact, the bowing outwardly and inwardly of the diaphragm from the normal position tending to increase or decrease the initial pressure.

According to another modification an inertia transmitter is constructed consisting of a diaphragm having a rubber fixture thereon, a flat or other spring serving to hold the weight in position, and an adjusting screw whose ends rest upon a carbon disc. The operation is the same as in the device constructed according to the mode first hereinbefore described of carrying out this Invention.

A double inertia transmitter may be constructed having two carbons connected together, hence the difference of pressure takes place at two points. The carbons in the device first described and in the two latter inertia transmitters may be fastened to their cups permanently or they may be loose, the latter is preferable.

According to another modification an inertia telephone is constructed in the following manner:—A diaphragm, carbon button, and rubber standard are employed with a weight, which is of iron, and is secured to a spring which may be made adjustable. A permanent magnet is also provided, which may be made to approach or recede from the weight, and thus increase or decrease the initial pressure on the carbon.

One of these transmitters may be secured to a diaphragm, which in its turn may be pasted to a larger rubber diaphragm.

Another form of inertia transmitter consists of a carbon and a quantity of mercury both in a tube with an opening through which one of the wires passes, the whole being secured to the diaphragm.

In another form uprights are secured to the rubber piece which is secured to the diaphragm; the carbon rests on the platinized surface of a screw, which serves also to connect the rubber piece with the diaphragm.

A weight is provided, which may be made of a pointed shape, and a spring which serves to give to the weight an initial pressure and hold it in position; a screw may be connected from the spring to the point of the weight, and thereby made adjustable.

A diaphragm with the inertia transmitting devices upon it may be secured to a wooden case by strings or elastics.

A further variation of this type of transmitter consists of an upright attached to the diaphragm, the upper end of which upright is platinized and rests upon a carbon disc which is in an adjustable cup.

The movement of the diaphragm increases and decreases the pressure upon the carbon. Or the transmitter may consist of a diaphragm and a spring lever which is given a side motion by the movement of the diaphragm by means of a bevel piece which connects the lever with the diaphragm. The carbon button against which the spring rests suitably suspended and closes the circuit; the pressure is regulated by the movement of the diaphragm.

A double lever may be employed, the carbon being between the two; the bevel piece serves to separate both levers simultaneously, and they carry their carbon button with them.

The block connected to the diaphragm may receive a hard carbon rod against which the springs rest; they are bevelled, any outward movement of the diaphragm tending to increase the pressure. A carbon wheel may be used in lieu of the rod and between double springs.

According to a further modification, an inertia telephone is constructed with two carbons connected together, and resting on these carbons is a weight which is kept upon them by a spring around an insulating rod, a nut being provided for increasing or decreasing the tension of the spring. Or the diaphragm may have a

block to which is secured a carbon, whilst on the latter rests two springs, the forward movement of the diaphragm increasing the pressure at both points of contact. Or a cup may be employed with a carbon rod in it, whilst upon the carbon rests a lever, the initial pressure of which may be varied by an electro-magnet, which may be the primary coil of the inductorium or disconnected therefrom, or it may be a permanent magnet, or even a spiral or flat spring may be used, or if the diaphragm is held in the right position its own weight may be used.

Another modification consists of an upright in the base of which is the carbon; on this rests a weight, a hole being drilled through it into which passes the rod around which the adjusting spring is coiled, this serves to hold the weight in position; by means of a nut the initial pressure may be regulated.

Or the carbon connected to the diaphragm may be acted upon by a pendulous spring with carbon tips upon its extremity resting against the carbon, a weight being also employed.

According to a further modification of inertia transmitter, weights are secured to a lever pivotted from an arm which connects with a diaphragm; the centre of this lever rests upon a carbon button in a cup upon the diaphragm; one of the weights is adjustable so as to adjust the initial pressure.

Or four springs may be used secured to an insulating block upon the diaphragm; the current enters via the first spring, thence passes through its carbon tips to the carbon tips of the second, third, and fourth springs, and out by the fourth spring.

According to another part of this Invention a receiver is constructed upon the electro motograph principle in the following manner:—It consists of a diaphragm, a disc of chalk or other inert substance saturated with phosphate of soda or other proper chemical, to produce the motograph action, and a spring connecting the diaphragm with the disc tipped with palladium.

The shaft of the disc is rotated by a worm and worm wheel.

An inertia telephone may be secured to a strip of elastic material instead of a diaphragm; it is held against its case by springs which are tipped with rubber or other soft substance.

The motograph receiver may be arranged as a transmitter, the same consisting of a diaphragm, a spring connecting the same with the chalk; the chalk in this case is not rotated.

This apparatus is included in a primary circuit of an induction coil having a high resistance; a battery is provided; a magneto receiver may be used or a receiver an exact copy of the transmitter.

The action is as follows:—

When the diaphragm is vibrated by the voice it sets in motion the spring, this instantly depolarizes the point of contact between it and the chalk, thus increasing the flow of current from the battery; the instant the spring comes to rest it polarizes and weakens the current from the battery.

The motograph may also be arranged to transmit direct from one to the other without the intervention of an induction coil, also arranged so that they can by raising a lever be made receivers or transmitters. A rubber pressor is used to press the spring from the diaphragm down upon the chalk when receiving; the lever is provided with a handle and limiting stops are also used. A spring is further provided, also a roller, which serves to hold the lever when it is drawn up or down; both instruments are similar in construction. When receiving, the pressure is put on the spring resting upon the chalk and it is rotated, but when transmitting the pressure on the spring is light and the chalk is not rotated.

The telephone may further be constructed so that each sound wave is made of an aggregation of smaller waves.

A lever is provided suitably pivotted, and near its fulcrum is an arm connecting it with the diaphragm. One end of the lever rests lightly upon a block of finely divided conducting matter, which block is connected to one part of the circuit, whilst the lever

is connected to the other part; the vibration of the diaphragm serves to reciprocate the lever or spring over the surface of the block. I provide a push button arranged to open the receiver circuit when transmitting, and, *vice versa*, open the transmitting circuit when receiving, thus preventing the tertiary or primary coils of the inductorium from short circuiting each other's currents.

When the lever of the push key is up, the tertiary coil is connected through the primary with the receiver; when down, the carbon transmitter is connected in circuit and the tertiary circuit broken. The two chemical receivers may be situate in the main line with a condenser, the latter to prevent the circulation of earth currents through the chalk and thus deteriorate them.

The tertiary coils are thus dispensed with.

I may mention that sticks, buttons, or discs of finely divided conducting matter, may be made of the following named materials:—Carbon, lamp black, anthracite coal, bog coal, cannel coal, bituminous coal, retort carbon, carrea carbon, coke carbon, carbon from charring organic matter, amorphous carbon, charred diamond charcoal from organic matter, graphite, plumbago, blacklead, carburet of iron, and other carburets of the metals, metallized carbon, metallized graphite, metallized blacklead, metallized lamp black, peroxide lead, peroxide manganese, iodide copper, sulphide tin, sulphide iron, sulphide copper, sulphide antimony, sulphide nickel, sulphide cobalt, chalcopyrite pyrites, sulphide bismuth, sulphide lead, galena, plumbic sulphides, sulphide chromium, sulphide mercury, and all the conducting sulphides, also powdered platinum, rhodium, ruthenium, palladium, iridium, tin, copper, lead, zinc, iron, chromium, titanium, aluminium, antimony, arsenic, barium, bismuth, borax, cadium, calcium, caridm, cobalt, columbium, didymium, eubium, glucinum, gold, lanthanium, lithium, magnesium, manganese, mercury, molybdinium, nickel, mobium, norium, pelopium, amorphous phosphorus, selenium, silicon, silver, sodium, stratium, tellurum, terbium, thornum, tungsten, uranium, vanadium, yttrium, zinc, zirconium, magnetic oxide of iron, daryium, gallium.

Any known substance which conducts electricity, and which can be powdered, may be moulded by itself, or mixed with one or more other conducting or nonconducting substance to form the tension regulator for a telephone.

For making the case of the telephone, any known wood, metal, or manufactured or native substance may be used.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Joseph Bond Morgan in the Great Seal Patent Office on the 8th June 1881.

JOSEPH BOND MORGAN, of Coleman Street, in the City of London, "IMPROVEMENTS IN TELEPHONES." A communication from abroad by Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America.

This Invention relates chiefly to improvements upon the carbon telephone, in respect of which Letters Patent were granted to the said Thomas Alva Edison, dated the 30th day of July 1877, No. 2909, and 15 day of June 1878, No. 2396. In telephones heretofore made use of the electric current has passed through carbon, or similar material having inferior conducting properties, and the movement of the diaphragm as it responds to the atmospheric vibrations has applied more or less pressure of the metallic electrodes against such carbon, and the electric current on the line has thereby been varied so that at the distant station the current acting in an electro-magnet has given corresponding movements to the diaphragm of the receiving instrument.

The object of the present Invention is to allow the diaphragm to respond to the atmospheric vibrations without being unduly checked, and at the same time to ensure the necessary pressure and extent of surface contact between the carbon or similar material and the electrodes to produce the corresponding electric changes or undulations in the line.

In the Drawings the present improvements are shown in some of the various forms which have been availed of for use in transmitting articulate speech. In these Figures the diaphragm is represented at *a* with a suitable case *b* and mouth piece *c*, the diaphragm *a* resting upon or being secured at its edges to the said case *b*. The carbon or similar material for regulating the electric condition of the line is shown at *i*.

In the sectional plan, Fig. 1, the carbon *i* is in a cup *d* of insulating material, such as hard rubber. One metallic electrode *e* is in the form of a metal rivet that holds the cup *d* to the diaphragm, the carbon rests against this. The other electrode is in the form of a platina disk at the end of the screw *f* that passes through the spring *g* that is connected at its ends to the cup *d* so that the proper initial pressure is applied to the carbon by the screw. There is a weight *h* carried by the spring, and one wire *k* is connected to the diaphragm, and the other wire *l* to the spring *g*. The vibrations of the diaphragm produced by speech or other sounds act upon the atmosphere and vary the electric condition of the circuit passing to the distant instrument in consequence of the weight *h* acting by its inertia to vary the pressure on the carbon. When the pressure is the greatest the resistance will be the least, and the electric current will flow most freely; and when the pressure is less the surface contact with the carbon will be less, and the electric current will be diminished in proportion. This mode of operation holds good in all the telephone instruments herein described where the carbon is between a weight and the diaphragm, the former acting by its inertia to vary the pressure on the carbon.

Owing to the inertia of the weight, and its not being able to follow any rapid movements of the diaphragm, there results a difference of pressure between the electrodes and the carbon. The screw or electrodes may also be tipped with carbon, in fact several thin wafers of carbon may be used, or a disk or piece of any shape may be used. The weight may be round, square, half round, oblong, oval,

or in any configuration so long as it is a weight. It may be a hollow sphere, tube, or other shape, and be filled with mercury or any other heavy substance.

The spring *g* may be broad or narrow, and may be bent in any shape between the weight and disk upon the diaphragm.

The circuit wires may be connected to the primary coil of an inductorium with a battery in circuit.

Fig. 2 is the same as Fig. 1, only the spring *g* is nearly straight instead of being elliptical. In Fig. 3 the adjusting screw *f* is made to act upon a magnet that varies the initial pressure upon the carbon by its proximity to the weight *h*, which is to be of iron. The closer the pole of the magnet is to the iron weight the more the attraction will be to draw the weight from the carbon, and lessen the pressure exerted by the spring *g* that carries the weight, and the *vice versa*.

In Fig. 4 two weights *h* with separate springs *g* are shown acting upon separate pieces of carbon. The current passes from *k* through one spring and weight, through the first carbon and the electrode connected to the diaphragm, and back through the other electrode *e*, and carbon weight and spring to the other wire *l* of the circuit; the operation is as before set forth. The pressure of the springs and weights on the carbons will be varied by the screws that attach the springs to the cups or arms *d*.

In Fig. 5 the weight *h* is sustained by the spring *g* that is supported upon arms that intervene between the ends of the spring and the cup *d*; otherwise it is similar to the device shown in Fig. 1.

Fig. 6 represents the inertia transmitter as upon a small diaphragm *a*, and this is secured by adhesive material to a larger diaphragm a^2, which may be of stretched india rubber or other suitable material. The inertia of the weight causes the variations in pressure upon the carbon as the parts are vibrated by the sound waves acting on the diaphragm a^1.

When a diaphragm is fastened at its edges and vibrated by the action of the sound waves in the atmosphere it becomes alternately convex and concave to a very slight extent. This is availed of to produce more or less pressure between two pieces of carbon *i*, Figs. 7 & 8, that are fastened upon the diaphragm, and their faces touch each other. The circuit wires *k*, *l*, are connected to the clamping devices of the respective pieces of carbon. The spring b^1 and set screw b^2 serve to apply more or less yielding pressure to the diaphragm, and bow the same, and regulate the initial pressure of one carbon against the other.

By placing the carbon *i*, Fig. 9, against an arm *n* that is platinized at the point of contact the vibrations of the diaphragm and its change of shape vary the pressure of the arm upon the carbon, and produce rise and fall of electric tension as aforesaid.

The same effect is produced when the carbon *i*, Fig. 10, is between two spring arms *n*, n^1, and there is a double wedge shaped projection *o* on the diaphragm that acts to spread the springs or allow them to approach closer as the diaphragm *a* and wedge *o* vibrate, and thereby the pressure on the carbon is varied.

A single incline *o*, Fig. 11, may be employed with a spring *n* to act as aforesaid. In this case the stock *p* that carries the spring and carbon is to be adjusted by the screw *f* to vary the position of the parts to the incline, and the consequent initial pressure of the spring upon the carbon.

In Fig. 12 the carbon is in a cup that is adjusted by the screw *f*, and the incline *o* acts upon a spring arm *n* that bears against the carbon.

In Figs. 13 and 14 the carbon *i* is in the form of a small rod passed through a stud upon the diaphragm. In Figure 13, spring arms *n*, n^1, with inclined ends similar to those in Fig. 10, bear upon the carbon; the ends of these arms should be of platina or similar metal that is not injured by the electric action; this is also to be the case in all the electrodes that bear on the carbon.

In Fig. 14 the spring arms *g* bear directly on the carbon, and the weights *h* are comparatively small; the action in both Figs. 13 & 14 is the same as before

described, except that the motion of the diaphragm and carbon against the spring arms varies the electric tension of the line.

In Figs. 15 and 16 the carbon is in the form of a roller *i*, bearing against the inclined ends of the springs. In Fig. 15 only one spring *n* is shown, in Fig. 16 there are two springs *n*, n^1.

In Fig. 17 the weight *h*, carbon *i*, and cup *d* are similar to those in Fig. 1, but the spring *g* is helical, and its back end supported by an arm.

In Fig. 18 there are two carbons *i*, against which the weight *h* and spring *g* act, and the circuit is through the carbons, the wires being connected to a piece of platina in each recess that holds one of the carbons. In these Figs. 17 & 18 there is a hole in each weight for the rod e^2 to pass through, which rod holds the weight in position.

Instead of the diaphragm resting at its edges upon the case it may be suspended by cords or wires 1, 2, 3, 4, shown in Fig. 19. It is preferable to use cords of india rubber to prevent the diaphragm continuing to vibrate, and transmit incorrect electric pulsations after the atmospheric sound waves have ceased.

The same effect is produced by spring fingers tipped with rubber bearing against the diaphragm, as shown at b^3, Fig. 20. In this instance the circuit regulator and inertia transmitter are shown upon a strip, it not being necessary to employ a round diaphragm.

In Fig. 21 a magnet b^2 is represented for applying the initial pressure to the carbon; this magnet acts through a lever upon the carbon *i*. The circuit of this electro magnet may pass through the primary of the inductorium, or the lever may be provided with weights *h*, as in Fig. 22, one of which weights may be adjustable, so as to apply the proper pressure to the diaphragm.

When the carbon is placed at one end of a tube e^3, as in Fig. 23, and mercury placed in the other part of the tube, the operation will be the same as before described, the mercury forming a resistance, and by its inertia varying the pressure of the electrodes on the carbon *i*.

In some cases three or four springs b^3 are secured in an insulating block upon the diaphragm, as in Fig. 24, each spring having a block of hard carbon *i* at its end. The circuit wires are connected to the first and last springs, and the varying pressure of the carbons against each other as the diaphragm is vibrated causes the rise and fall of tension in the circuit corresponding to the air waves acting on the diaphragm.

In Figure 25 there are two carbons *i*, one fastened to the diaphragm, the other to the spring *g*, and there may be a weight *h* to act by inertia to cause the carbons to press against each other with greater or less force, as the diaphragm is vibrated by the words spoken.

Having now described and particularly ascertained the nature of the said Invention, and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that what I consider to be novel and original, and therefore claim as the Invention secured to me by the herein before in part recited Letters Patent is,—

First. In a telephone instrument the combination with the diaphragm and carbon or similar material in the electric circuit of the weight or inertia resistance to vary the electric current in proportion to the vibrations of the diaphragm, substantially as set forth.

Second. The combination with the diaphragm and carbon or similar material of a lever and a magnet to vary the initial pressure upon the carbon, substantially as set forth.

Third. The combination with the weight and the diaphragm of two pieces of carbon or similar material in the electric circuit, and against which the weight acts, substantially as set forth.

Fourth. The combination with the diaphragm and carbon or similar material in the electric circuit of an incline that serves to vary the pressure on the carbon as the parts are moved by the diaphragm, as set forth.

Morgan's Improvements in Telephones.

Fifth. The combination with the weight and carbon of a diaphragm that is loose at its edges, and held by yielding supports, as set forth.

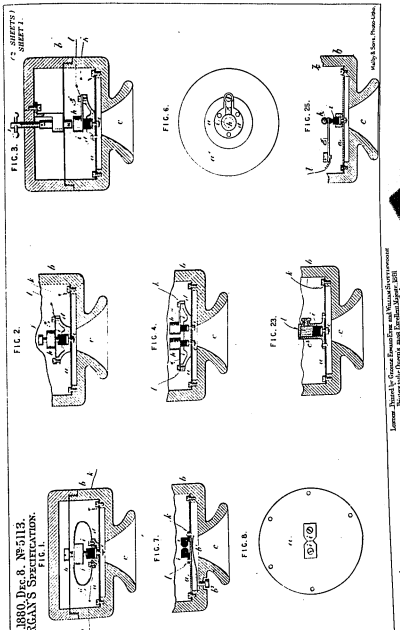
Sixth. The combination with the diaphragm of two pieces of carbon in contact with each other circuit connections and means for keeping the surfaces of the carbons in contact, as specified.

In witness whereof, I, the said Joseph Bond Morgan, have to this my Specification set my hand and seal, this Seventh day of June, One thousand eight hundred and eighty one.

JOSEPH BOND MORGAN. (L.S.)

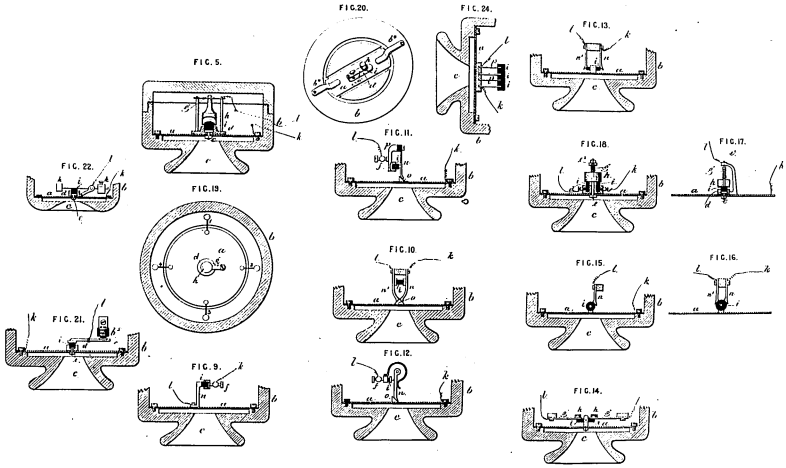
LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1881.



A.D.1880. Dec. 8. No. 5113.
MORGAN'S SPECIFICATION.

(2 SHEETS)
SHEET 2.



Malby & Sons, Phot. Lith.

London.—Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1881.

BATCHELOR COLLECTION, UNBOUND DOCUMENTS, 1871-1911

The correspondence, technical notes, and other unbound documents in the Batchelor Collection relate primarily to Batchelor's work with Edison during the period 1878-1898. Included among the correspondence from 1878 are a substantial number of letters about the phonograph, which are similar to those found in the "Edison, T.A. - Advice" folder in the Document File Series. Many of the documents from the 1880s pertain to Batchelor's activities as manager of the Edison electric light interests in France (1881-1884) and as manager of the Edison Machine Works (1884-1888). The correspondence from the 1890s is mainly concerned with Batchelor's stock holdings. Important correspondents include Edison, Francis R. Upton, Jay Gould, Henry Villard, and Cyrus W. Field.

There is also a substantial amount of technical material, much of it in Edison's hand. Included are notes and drawings relating to electroplating and thermoelectricity experiments (1879), designs for a portable photometer (1883), and ore milling experiments (1898). There are also some drawings of the Garnier engine; notes and charts on lamps, mostly from the lamp factory in Paris; generator tests; and an undated chart on dynamos, listing specifications of the various models.

Included also are agreements and other documents relating to the Edison Phonograph Works; a bond and mortgage for property owned by Batchelor in Newark, New Jersey; a memoir by Batchelor, written about 1905, concerning Edison's early work on incandescent lighting during the fall of 1878; and agreements by Edison for rights to his electric pen, phonograph, and telephone, along with additional agreements concerning royalties owed to Batchelor for his assistance in developing these inventions. There are some financial documents, mostly relating to Batchelor's personal finances. These include statements of his accounts (1881-1889) and a promissory note (1884). Other financial material concerns the finances of the Edison Phonograph Works (1889 and 1897) and inventories from the lamp factory in Paris (1882-1884).

The following categories of documents have not been filmed: routine lamp tests (1883-1885); Batchelor's stock certificates (1884-1900); personal and business correspondence after 1900 unrelated to Edison; correspondence among members of Batchelor's family and other family-related documents; correspondence and other documents relating to Batchelor's role as executor of the estate of John Kruesi; routine documents such as forms, circulars, formal invitations, and undated newspaper clippings.

CHARLES BATCHELOR COLLECTION

1871–1876

New Jersey
Essex County } ss.

Be it remembered that on this 28th day of August Eighteen hundred and seventy one before me a Master in Chancery of New Jersey personally appeared Robertson Boalle of full age who being by me duly sworn according to law upon his oath saith that Mr. and Mrs. Charles Batchelor the Grantor in the within Indenture of Mortgage named sign, seal and deliver the same as his voluntary act for the uses and purposes therein expressed; and this deponent subscribed his name thereto as witnessing witness

Sworn and subscribed this 28 day of August AD 1871 before me

R. Robertson Boalle

J. Martin

Recorded and Indexed by Martin Dennis Co. Printers Law Publishers, Newark, N.J.

Received for Record Sept. 13 1875 at 3 o'clock P.M. and Recorded in Book 490 of Mortgages for said County, on Pages 147 & 148

Examined

Charles Batchelor
Peter Campbell
Mortgagors

MORTGAGE

Dated August 28 1871

Recorded Sept. 13 1875

Robertson, Boalle
Mortgagee

Office of the County of Essex, N.J.

MORTGAGE—Fire and Tax Clause. Printed by Martin B. Dennis & Co.

This Indenture, made the First day of August in the year of our Lord One Thousand Eight Hundred and Seventy one Between

Charles Batchelor

of the City of Newark in the County of Essex and State of New Jersey of the first part: And

Peter Campbell

of the City of Newark in the County of Essex and State of New Jersey of the second part:

Witnesseth: That the said party of the first part, for and in consideration of the sum of Six Hundred and Fifty Dollars lawful Money of the United States of America, to him in hand well and truly paid by the said party of the second part, at or before the sealing and delivery of these presents, the receipt whereof is hereby acknowledged, and the said party of the first part therewith fully satisfied contented and paid, hath given, granted, bargained, sold, aliened, enfeoffed, conveyed and confirmed, and by these presents doth give, grant, bargain, sell, alien, enfeoff, convey and confirm to the said party of the second part, and to his heirs and assigns forever: All that certain tract or parcel of land and premises, hereinafter particularly described, situate, lying and being in the City of Newark in the County of Essex and State of New Jersey

Beginning at the South East corner of North Sixth Street and Second avenue thence running Southerly along the Easterly line of North Sixth one hundred feet thence Easterly at right angles to North Sixth Street and parallel with Second Avenue seventy five feet thence Northerly parallel with North Sixth Street one hundred feet to Second Avenue and thence Westerly along the Southerly line of Second avenue seventy five feet to the place of Beginning

Being known and designated as lot numbers 38, 39 and 40 on Block "G" on a Map entitled "The property belonging to Peter Campbell for private in the City of Newark N.J. adjoining the proposed park of

the billy and

Being the same premises conveyed to the said Charles Batchelor by deed from Peter Campbell and Sarah J his wife bearing even date herewith this Mortgage being given to secure a part of the Consideration money therefor

Together *with all and singular the profits, privileges and advantages, with the appurtenances to the same belonging or in any wise appertaining;* **Also,** *all the estate, right, title, interest, property, claim and demand whatsoever, of the said party of the first part, of, in and to the same, and of, in and to every part and parcel thereof:* **To Have and to Hold,** *all and singular the above described land and premises, with the appurtenances, unto the said party of the second part, his heirs and assigns, to the only proper use, benefit, and behoof of the said party of the second part, his heirs and assigns, forever.*

Provided always, *and it is agreed by and between the parties to these presents, that if the said*

Charles Batchelor his

heirs, executors, or administrators, do and shall well and truly pay, or cause to be paid, to the said party of the second part, or to his certain attorney or attorneys, heirs, executors, administrators, or assigns, the sum of

Six hundred and fifty dollars lawful money aforesaid in five years from the date hereof

Recd. Six Hundred And fifty Dlls in full

August 22 1887 Peter Campbell

with lawful interest for the same, at the rate of seven per centum per annum, payable

semiannually

according to the condition of a certain Bond bearing even date herewith, in the penal sum of

Thirteen hundred Dollars

together with all National, State, County and City Taxes which may be assessed upon the money now loaned and hereby secured to be paid; which Taxes, if they shall be paid by the said party of the second part, shall, with interest thereon, be a lien upon the premises hereby conveyed, and recoverable at the same time, and in the same manner as the principal and interest secured to be paid by this mortgage;

without any deduction or defalcation for taxes, assessments, or any other imposition whatsoever: then, and from thenceforth, these presents and said obligation, and everything herein and therein contained, shall cease and be void; anything herein and therein contained to the contrary in any wise notwithstanding; and the said

Charles Batchelor for himself his

heirs, executors and administrators, do covenant and grant to and with the said party of the second part his heirs and assigns, that the said party of the second part his heirs and assigns, shall and may from time to time, and at all times after default shall be made in the performance of the proviso or condition herein contained, peaceably and quietly enter into, have, hold, use, occupy, possess, and enjoy all and singular the above granted and bargained premises with the appurtenances, without the let, suit, trouble, hindrance or denial of the said

Charles Batchelor his

heirs or assigns, or of any other person or persons whatsoever.

And *it is also agreed by and between the parties to these presents, that the said party of the first part shall and will keep the buildings erected and to be erected upon the lands above conveyed, insured against loss or damage by fire, in some safe and responsible Insurance Company or Companies, to an amount not less than*

dollars, and assign the policy and certificate thereof to the said party of the second part as collateral security for the payment of the principal and interest aforesaid; and in default thereof, it shall be lawful for the said party of the second part to effect such insurance, and the premium and premiums paid for effecting the same shall be a lien on the said mortgaged premises, added to the amount of the said Bond or obligation, and secured by these presents, and payable on demand with legal interest.

In Witness Whereof, *the said party of the first part hath hereunto set his hand and seal the day and year first above written.*

Signed, Sealed, and Delivered in the presence of

Chas. Batchelor

Robt. Wm. Cowell

BOND.

Charles Batchelor

to

Peter Campbell

Dated, August 1st 1871

WILLIAMS & ELLIM,
LAW BLANK PUBLISHERS,
NEWARK, N. J.

BOND.—With Special Condition. WILLIAMS & ELLIM, Law Blank Publishers, Newark, N. J.

Know all Men by these Presents, THAT

I Charles Batchelor

of the City of Newark in the County of Essex and State of New Jersey am held and firmly bound unto

Peter Campbell

in the sum of Thirteen Hundred Dollars

lawful money of the United States of America to be paid to the said

Peter Campbell

or to his certain Attorney, Executors, Administrators or Assigns: To which payment well and truly to be made, I bind myself my Heirs, Executors and Administrators, firmly by these presents. Sealed with my Seal and dated the First day of August in the year of Our Lord One Thousand Eight Hundred and Seventy one

The Condition of the above Obligation is such, *That if the above bounden*

Charles Batchelor his

Heirs, Executors and Administrators, shall well and truly pay or cause to be paid unto the above named

Peter Campbell his

Executors, Administrators or Assigns, the just and full sum of

Six Hundred and Fifty Dollars

lawful money aforesaid in five years from the date hereof with lawful interest for the same at the rate of seven per cent. per annum payable semi-annually together with all National State County and City taxes which may be assessed upon the money now loaned and hereby secured to be paid or upon this obligation or the indenture of Mortgage given to secure the payment of the same and bearing even date herewith

without any fraud or other delay, then the above Obligation to be Void, otherwise to remain in full force and virtue.

And it is hereby expressly Agreed, That should any default be made in the payment of the said interest, or any part thereof, on any day whereon the same is made payable, as herein before expressed: And should the same remain unpaid and in arrear for the space of Ninety days, then and from thenceforth, that is to say, after the lapse of the said Ninety days, the aforesaid principal sum of money, with all arrearage of interest thereon, shall at the option of the said

Peter Campbell his

Executors, Administrators or Assigns, become and be due and payable immediately thereafter, although the time above limited for the payment thereof may not then have expired, anything herein before contained to the contrary thereof in anywise notwithstanding.

Signed, Sealed and Delivered in the presence of

Robt. John Castle

Chas. Batchelor

Newark Feby 1 1872 Recd of Charles Batchelor interest on the Wm in Bond of 650.00 $22.75 Peter Campbell	22	75
Received of Charles Batchelor Twenty two Dolls 75 interest up on the Walley Bond Augt 1 1872 Peter Campbell	22	75
Newark Feby 1 1873 Recd of Mr Charles Batchelor interest in full on the Wm Bond Peter Campbell	22	75
$22.75 Rec Aug 1. 1873 Six months int on within Bond Peter Campbell Jno 1875	22	75
$22.75 Recd Feb. 1st 1874 Six months int on within bond.		
Recd Aug 1 1874 Twenty two 75 Six months interest on Bond Peter Campbell the Campbell	22.	75
Received Feby 1 1875 twenty two Dolls 75 Six months interest Peter Campbell	22	75
Received Aug 1st 1875 twenty two Dollars & 75/100 Peter Campbell	22	75

New York Feby 10 1875.

Mr Chas Batchelor

Dear Sir

I accept your proposition of Feby 7th 1875 relating to a Stock operation printing telegraphy and will pay the sums of money mentioned therein upto conditions are fulfilled.

Yours truly

Jay Gould

United States of America.

State of New Jersey, } ss.
County of Essex,

At a Court of Common Pleas, holden at Newark, in and for the County of Essex, of the Term of January *in the year of Our Lord One Thousand Eight Hundred and Seventy-* Five

Be it Remembered, *That on the* Fifteenth *day of* March *in the year of Our Lord One Thousand Eight Hundred and Seventy-* Five

Charles Batchelor

an Alien personally appeared in open Court, and prayed to be admitted to become a Citizen of the United States, pursuant to the direction of the several Acts of Congress of the United States of America, and the Supplements thereto, in such case made and provided: and the said Applicant having thereupon produced to the Court such evidence, made such declaration and renunciation, and taken such oaths as are by said Acts required:

It is Thereupon Ordered by the Court, *That the said Applicant be admitted to all the rights, privileges and immunities of*

A Free Citizen of the United States of America.

STATE OF NEW JERSEY, } ss.
COUNTY OF ESSEX,

J. J. BANKS REFORD, *Clerk of the Court of Common Pleas, in and for the County of Essex, do hereby certify that the foregoing is a true transcript from the Records of Naturalization of said Court, as the same remain in my office.*

In Testimony Whereof, *I have hereunto subscribed my name, and affixed the seal of the said Court, at Newark, in the County of Essex aforesaid, the day and year last aforesaid.*

J. Banks Reford Clerk

Whereas I, Thomas A. Edison of Newark in the State of New Jersey, have invented certain Apparatus for Autographic Printing and I am about to apply for Letters Patent for the same in the Dominion of Canada. And Whereas Robert Gilliland of Hudson, Michigan is desirous of acquiring a certain interest in the said Letters Patent.

Therefore in consideration of one dollar in hand paid the receipt of which is hereby acknowledged, I do hereby agree that I will transfer to the said Robert Gilliland for the use and behoof of him or his legal representatives, as soon after the issue of the said patent as he may request, three undivided tenths of the entire right, title and interest in and to said Canadian Letters Patent, the conditions of the said assignment being as follows. That the profits resulting from the Letters Patent whether from joint or separate efforts are to be divided in proportion ~~in proportion~~ to the interest held in the Letters Patent, and that neither party shall dispose of or encumber his interest without first offering it to the other party at the same price he can obtain from third parties.

As Witness my signature and seal this eighth day of February 1876.

Witness
Chas Batchelor

Thos A Edison

CHARLES BATCHELOR COLLECTION

1878

THIS AGREEMENT ENTERED INTO THIS SEVENTH DAY OF JANUARY EIGHTEEN HUNDRED AND SEVENTY EIGHT BY AND BETWEEN THOS. A. EDISON OF MENLO PARK, MIDDLESEX COUNTY, STATE OF NEW JERSEY AND DANIEL M. SOWERS OF THE CITY, COUNTY AND STATE OF NEW YORK AND HENRY J. DAVIES OF BROOKLYN, COUNTY OF KINGS AND STATE OF NEW YORK, WITNESSETH:

WHEREAS THE SAID EDISON IS THE INVENTOR OF A NEW METHOD FOR RECORDING AND REPRODUCING THEREFROM THE HUMAN VOICE AND OTHER SOUNDS BY CAUSING SUCH SOUNDS TO VIBRATE A MOBILE BODY THE MOVEMENTS OF WHICH ARE RECORDED BY UNDULATION, DISPLACEMENT, SUBSTRACTION FROM, OR DEPOSIT UPON ANY MATERIAL AND THE REPRODUCTION OF THE MOVEMENTS OF SUCH MOBILE BODY BY CAUSING ITS RECORD OR A COPY THEREOF TO GIVE MOTION TO ANOTHER OR THE SAME MOBILE BODY FOR WHICH HE DID APPLY FOR A PATENT IN THE UNITED STATES PATENT OFFICE DECEMBER 15TH, 1877.

AND WHEREAS THE SAID SOWERS AND DAVIES ACTING TOGETHER AND NOT SEPARATELY ARE DESIROUS OF APPLYING THE PHONOMETIC APPARATUS OF THE SAID EDISON TO CLOCKS AND WATCHES, TO CAUSE SUCH CLOCKS OR WATCHES TO CALL OUT THE TIME AT CERTAIN INTERVALS AND TO REPRODUCE SOUNDS SINGING OR SHORT SENTENCES NOT EXCEEDING WORDS. SUCH APPARATUS BEING ACTUATED EITHER BY THE CLOCK OR WATCH MOVEMENT ITSELF OR FROM A SUBSIDIARY MOVEMENT PLACED WITHIN SUCH CLOCK OR WATCH. SUCH WORDS AND SOUNDS BEING SOLELY INTENDED AND ADAPTED TO REPLACE [OR TO BE IN ADDITION TO] THE STRIKING AND ALARM MOVEMENT IN CLOCKS AND WATCHES..

THEREFORE BE IT AGREED THAT FOR AND IN CONSIDERATION OF THE SUM OF ONE DOLLAR IN HAND PAID TO THE SAID EDISON BY

THE SAID SOMERS AND DAVIES THE RECEIPT OF WHICH IS HEREBY ACKNOWL-
EDGED AND FOR OTHER AND FURTHER VALUABLE CONSIDERATIONS AND AGREE-
MENTS HEREINAFTER MENTIONED THE SAID EDISON GRANTS TO THE SAID
SOMERS AND DAVIES JOINTLY BUT NOT INDIVIDUALLY THE SOLE AND EXCLU-
SIVE LICENSE AND RIGHT TO MANUFACTURE OR CAUSE TO BE MANUFACTURED
TO APPLY AS AFORESAID AND SELL WITHIN THE UNITED STATES OF AMERICA
ONLY, AND FOR CONSUMPTION OR USE WITHIN THE UNITED STATES ONLY
AND NOT FOR EXPORT TO ANY FOREIGN COUNTRY THE INVENTION OF SAID
EDISON HEREIN SET FORTH WHEN APPLIED TO CLOCKS AND WATCHES FOR THE
PURPOSE SPECIFIED, BUT FOR NO OTHER PURPOSE WHATSOEVER. WHICH
LICENSE AND RIGHT AND THIS CONTRACT IS TO CONTINUE FOR A PERIOD
OF FIVE YEARS FROM THE DATE HEREOF PROVIDED HOWEVER THAT THE SAID
SOMERS AND DAVIES EXERCISE REASONABLE DILIGENCE IN APPLYING SUCH
INVENTION TO CLOCKS AND WATCHES OR CLOCKS ALONE, AND ENDEAVOR TO
ESTABLISH A PERMANENT BUSINESS FOR THE SALE OF SUCH APPARATUS IN
THE CONNECTION MENTIONED: AND SHALL MAKE TRUE AND CORRECT RETURNS
UNDER OATH ON OR BEFORE THE 15TH, DAY OF EACH AND EVERY MONTH TO
THE SAID EDISON OF ALL SALES OF SUCH APPARATUS DURING THE PREVIOUS
MONTH FOR SUCH APPLICATION AND SHALL AT THAT TIME WELL AND TRULY
PAY TO THE SAID EDISON TEN PER CENT. ON THEIR ACTUAL SELLING PRICE
WHICH PERCENTAGE SHALL AMOUNT TO NOT LESS THAN ONE AND A HALF
CENTS FOR EACH CLOCK AND ONE AND A HALF CENTS FOR EACH WATCH.
IT IS EXPRESSLY AGREED AND UNDERSTOOD BY THE SAID SOMERS AND DAVIES
THAT NOTHING IN THIS CONTRACT SHALL BE CONSTRUED TO GIVE THEM THE
SAID SOMERS AND DAVIES ANY RIGHT WHATSOEVER TO MANUFACTURE OR
CAUSE TO BE MANUFACTURED OR SELL OR GRANT TO OTHERS ANY RIGHT TO
SELL OR MANUFACTURE ANY APPARATUS EMBODYING THE INVENTION OF SAID
EDISON EXCEPT WHEN SUCH APPARATUS IS APPLIED TO CLOCKS OR WATCHES

AFORESAID, AND ONLY FOR THE PURPOSES SPECIFIED.

IT IS FURTHER AGREED THAT IF THE SAID SOMERS AND DAVIES FAIL TO RENDER SUCH TRUE AND CORRECT MONTHLY STATEMENT OF ALL SALES, OR APPARATUS MANUFACTURED OR CAUSED TO BE MANUFACTURED FOR EACH AND EVERY MONTH DURING THE CONTINUANCE OF THIS CONTRACT AS HEREIN PROVIDED OR FAIL TO PAY THE SUMS DUE TO THE SAID EDISON FOR ROYALTY AT THE PERIODS HEREIN MENTIONED OR IF THE TOTAL SUM PAID TO SAID EDISON ON ACCOUNT OF ROYALTIES SHALL BE LESS THAN THREE THOUSAND DOLLARS IN EACH AND EVERY YEAR COMMENCING SIX MONTHS FROM THE DATE HEREOF, THEN THE SAID EDISON SHALL HAVE THE RIGHT TO TERMINATE THIS AGREEMENT AND ALL RIGHTS UNDER IT UPON GIVING THREE MONTHS PREVIOUS NOTICE IN WRITING OR THE SAID EDISON MAY IN THAT EVENT GRANT TO ANY OTHER PARTY OR PARTIES A LICENSE OR LICENSES TO MANUFACTURE SUCH APPARATUS. IT IS FURTHER PROVIDED THAT AFTER THE EXPIRATION OF THIS CONTRACT IT MAY AT THE OPTION OF THE SAID SOMERS AND DAVIES BE EXTENDED FROM YEAR TO YEAR DURING THE EXISTENCE OF THE PATENT FOR THE SAID INVENTION PROVIDING ALL THE PROVISIONS OF THIS CONTRACT HAVE BEEN CARRIED OUT IN GOOD FAITH AND THE ROYALTY PAID SAID EDISON HAS NOT BEEN LESS THAN THREE THOUSAND DOLLARS IN THE YEAR PREVIOUS TO THE DATE OF ITS TERMINATION.

IT IS FURTHER AGREED ON THE PART OF THE SAID SOMERS AND DAVIES THAT THEY WILL NOT TRANSFER THIS CONTRACT TO ANY OTHER PERSON OR PERSONS WITHOUT THE CONSENT IN WRITING OF THE SAID EDISON AND THAT THEY CAN NOT GRANT ANY LICENSE OR RIGHT TO MANUFACTURE TO ANY OTHER PARTY, BUT IN CASE OF DEATH OF EITHER SOMERS OR DAVIES, OR BOTH OF THEM, THE RIGHTS GIVEN BY THIS AGREEMENT SHALL EXTEND TO THE HEIRS OR EXECUTORS OF THE DECEASED UPON

THE TERMS HEREIN SET FORTH.

IT IS FURTHER AGREED THAT THE SAID EDISON WILL GRANT AND DOES HEREBY GRANT TO THE SAID SOMERS AND DAVIES THE RIGHT TO MAKE THREE SPEAKING PHONOGRAPHS TO BE USED SOLELY TO PRODUCE ORIGINAL MATRICES TO ENABLE DIES, ELECTROTYPES, OR CASTS TO BE MADE FROM THE RECORDS PRODUCED BY SUCH MACHINES FOR THE RAPID MULTIPLICATION OF SUCH RECORD TO BE USED IN THE CLOCKS AND WATCHES AFORESAID AND THESE MACHINES ARE TO BE USED FOR NO OTHER PURPOSE.

IN WITNESS WHEREOF WE HAVE HERCUNTO SET OUR HANDS AND SEALS THE DAY AND YEAR FIRST ABOVE WRITTEN.

Menlo Park N.J. January 7 1878.

The above contract of which this is a copy was made by me this day between the parties aforesaid now in consideration of the services performed by Chas Batchelor in experimenting for me in perfecting such apparatus I hereby agree to & will pay to the said Batchelor ten per cent of the said sum to be paid to me, that is to say for every hundred dollars received by me from this contract I agree to pay the said Batchelor ten (10) dollars & after paid me and this is to be binding upon my heirs or executors.

Witness,

Thos. A. Edison

THIS AGREEMENT ENTERED INTO THIS 7th DAY OF JANUARY EIGHTEEN HUNDRED AND SEVENTY EIGHT BY AND BETWEEN THOMAS A. EDISON OF MENLO PARK, MIDDLESEX CO. STATE OF NEW JERSEY AND OLIVER Q. RUSSELL OF THE CITY, COUNTY AND STATE OF NEW YORK, WITNESSETH:--

W H E R E A S THE SAID EDISON IS THE INVENTOR OF A NEW METHOD FOR RECORDING AND REPRODUCING THEREFROM THE HUMAN VOICE AND OTHER SOUNDS, BY CAUSING SUCH SOUNDS TO VIBRATE A MOBILE BODY THE MOVEMENTS OF WHICH ARE RECORDED BY INDENTATION, DISPLACEMENT, SUBSTRACTION FROM OR DEPOSIT UPON ANY MATERIAL, AND THE REPRODUCTION OF THE MOVEMENTS OF SUCH MOBILE BODY BY CAUSING ITS RECORD OR A COPY THEREOF TO GIVE MOTION TO ANOTHER OR THE SAME MOBILE BODY; FOR WHICH HE DID APPLY FOR A PATENT IN THE UNITED STATES PATENT OFFICE, DECEMBER 15TH 1877. AND WHEREAS THE SAID RUSSELL IS DESIRIOUS OF ENGAGING IN THE BUSINESS OF MANUFACTURING OR HAVING MANUFACTURED AND SELLING TO THE TOY TRADE APPARATUS ADAPTED ONLY TO THE FOLLOWING TOYS.

FIRST:-- TO DOLLS TO SPEAK SIXTY WORDS OR LESS OR MAKE VARIOUS SOUNDS.

SECOND:-- TO A TOY MUSICAL BOX WHICH SHALL PRODUCE BUT ONE TUNE, EITHER VOCAL OR INSTRUMENTAL AND SUITABLE ONLY FOR CHILDREN.

THIRD:-- TO A TOY SPEAKING BOX WHICH SHALL REPRODUCE SEVERAL SENTENCES, CONTAINING NOT MORE THAN SIXTY WORDS IN ALL.

FOURTH:-- TO TOY ANIMALS, BIRDS AND REPTILES TO MAKE VARIOUS SOUNDS AND TO MALE AND FEMALE HUMAN FIGURES TO UTTER SIXTY WORDS OR LESS.

FIFTH:-- TO TOY ENGINES TO WHISTLE AND IMITATE THE EXHAUST OF STEAM.

SIXTH:-- TO TOY TARGETS.

T H E R E F O R E BE IT AGREED THAT FOR AND IN CONSIDERATION OF THE SUM OF ONE DOLLAR IN HAND PAID TO THE SAID EDISON BY THE SAID RUSSELL, THE RECEIPT OF WHICH IS HEREBY ACKNOWLEDGED AND FOR OTHER AND FURTHER VALUABLE CONSIDERATIONS AND AGREEMENTS HEREINAFTER MENTIONED, THE SAID EDISON GRANTS TO THE SAID RUSSELL THE SOLE AND EXCLUSIVE LICENSE AND RIGHT TO MANUFACTURE, OR CAUSE TO BE MANUFACTURED AND TO SELL ~~TO THE TOY TRADE~~ WITHIN THE UNITED STATES ONLY AND FOR CONSUMPTION and use IN THE UNITED STATES ONLY AND NOT FOR EXPORT TO ANY FOREIGN COUNTRY THE APPARATUS APPLICABLE TO THE ARTICLES ENUMERATED HERETOFORE AND NUMBERED 1, 2, 3, 4, 5 AND 6, WHICH LICENSE AND RIGHT AND THIS CONTRACT, IS TO CONTINUE FOR A PERIOD OF FIVE YEARS FROM THE DATE HEREOF. PROVIDING HOWEVER THAT THE SAID RUSSELL DOES INVEST SUFFICIENT CAPITAL AT ONCE IN THE BUSINESS OF SUPPLYING THE TOY TRADE WITH SUCH APPARATUS AND DOES EXERCISE REASONABLE DILIGENCE IN PROSECUTING AND ESTABLISHING A PERMANANT BUSINESS FOR THE SALE OF SUCH APPARATUS AS HEREIN PROVIDED AND SHALL MAKE TRUE AND CORRECT RETURNS UNDER OATH ON OR BEFORE THE FIFTEENTH DAY OF EACH AND EVERY MONTH TO THE SAID EDISON OF ALL SALES OF SUCH APPARATUS MADE AND SOLD OR DELIVERED DURING THE PREVIOUS MONTH AND AT THAT TIME SHALL WELL AND TRULY PAY TO THE SAID EDISON TEN PER CENT ON THE ACTUAL SELLING PRICE OF ALL ARTICLES SO MADE, SOLD OR DELIVERED.

IT IS FURTHER AGREED ON THE PART OF THE SAID EDISON THAT IF AT ANY TIME DURING THE CONTINUANCE OF THIS AGREEMENT THE SAID RUSSELL DESIRES TO APPLY THE APPARATUS HEREIN MENTIONED TO OTHER TOYS NOT HERETOFORE MENTIONED THEN HE SHALL HAVE THE RIGHT TO MAKE

AND SELL SUCH APPARATUS FOR THAT APPLICATION AND IT SHALL COME UNDER THE PROVISIONS OF THIS CONTRACT. PROVIDED HOWEVER THAT THE TOY TO WHICH THE APPLICATION IS DESIRED TO BE MADE IS STRICTLY A TOY FOR THE USE AND AMUSEMENT OF CHILDREN AND WHICH SHALL NOT BE USEFUL IN BUSINESS TRANSACTIONS OR IN THE ARTS, SCIENCES, OR FOR ANY USEFUL PURPOSE OTHER THAN FOR THE INSTRUCTION AND AMUSEMENT OF CHILDREN. IT BEING EXPRESSLY AGREED AND UNDERSTOOD BY THE SAID RUSSELL THAT NOTHING IN THIS CONTRACT SHALL BE CONSTRUED TO GIVE HIM THE SAID RUSSELL ANY RIGHT WHATSOEVER TO MANUFACTURE, OR CAUSE TO BE MANUFACTURED OR SELL OR GRANT TO OTHERS ANY RIGHTS TO MANUFACTURE OR SELL ANY APPARATUS EMBODYING THE INVENTION OF SAID EDISON HEREIN SET FORTH EXCEPT WHEN SUCH APPARATUS IS APPLIED TO THE TOY ARTICLES HERETOBEFORE MENTIONED OR WHICH MAY BE ADDED THERETO AS HEREIN PROVIDED.

IT IS FURTHER AGREED THAT THE SAID EDISON WILL GRANT AND DOES HEREBY GRANT TO THE SAID RUSSELL THE RIGHT TO MAKE THREE SPEAKING PHONOGRAPHS TO BE USED SOLELY TO PRODUCE ORIGINAL MATRICES TO ENABLE DIES, OR ELECTROTYPES OR CASTS TO BE MADE FROM THE RECORDS PRODUCED BY SUCH MACHINES, FOR THE RAPID MULTIPLICATION OF SUCH RECORDS TO BE USED IN THE TOYS AFORESAID, AND THESE MACHINES ARE TO BE USED FOR NO OTHER PURPOSE.

IT IS FURTHER AGREED THAT IF THE SAID RUSSELL FAILS TO RENDER A TRUE AND CORRECT MONTHLY STATEMENT OF ALL SALES FOR EACH AND EVERY MONTH DURING THE CONTINUANCE OF THIS CONTRACT AS HEREIN PROVIDED OR FAILS TO PAY THE SUMS DUE THE SAID EDISON AT THE PERIODS HEREIN MENTIONED OR OF THE TOTAL SUM PAID THE SAID EDISON ON ACCOUNT OF ROYALTY, SHALL BE LESS THAN SIX THOUSAND DOLLARS IN EACH AND EVERY YEAR COMMENCING SIX MONTHS FROM THE DATE HEREOF THEN THE SAID EDISON SHALL HAVE THE RIGHT TO TERMINATE THIS AGREEMENT

AND IT SHALL BECOME NULL AND VOID UPON GIVING THREE MONTHS PREVIOUS NOTICE IN WRITING OR THE SAID EDISON MAY IN THAT CASE GRANT TO ANY OTHER PARTY OR PARTIES A LICENSE OR LICENSES TO MANUFACTURE SUCH TOY APPARATUS.

IT IS FURTHER PROVIDED THAT AFTER THE TERMINATION OF THIS CONTRACT, IT MAY AT THE OPTION OF THE SAID RUSSELL BE EXTENDED during the existence of the said Patent for the FROM YEAR TO YEAR ~~THEREAFTER~~ PROVIDING ALL ~~ITS PROVISIONS HAVE BEEN~~ the provisions of this Contract have been CARRIED OUT IN GOOD FAITH AND THE ROYALTIES PAID SAID EDISON ~~HAS~~ have NOT BEEN LESS THAN SIX THOUSAND DOLLARS IN THE YEAR PREVIOUS TO THE DATE OF ITS TERMINATION.

THE SAID RUSSELL SHALL NOT TRANSFER THIS LICENSE TO ANY OTHER PARTY OR GRANT TO ANY PARTY ANY RIGHT OR PRIVILEGE THEREUNDER WITHOUT THE CONSENT IN WRITING OF THE SAID EDISON PREVIOUSLY OBTAINED BUT THE SAID RIGHTS MAY PASS TO THE HEIRS OR EXECUTORS OF SAID RUSSELL UPON THE CONDITIONS HEREIN CONTAINED.

IN WITNESS WHEREOF ~~WE~~ the parties have to their HAVE HEREUNTO SET OUR HANDS AND SEALS. the day of year first above written.

"Menlo Park" N.J. January 7 1878

The above Contract of which this is a copy was made by me this day between the parties aforesaid, now in consideration of the services performed by Chas Batchelor in experimenting for me in perfecting such apparatus I hereby agree to and will truly pay to the said Batchelor ~~one~~ ten (10) per cent of the said sums to be paid to me when paid me that is to say for Every hundred dollars received by me from the ~~Contract~~ I agree to pay the said Batchelor ten (10) dollars, this is to be binding on my heirs or executors.

Thos A Edison

Copy

This memorandum of agreement entered into this thirteenth day of January. Eighteen Hundred and Seventy Eight by and between Thomas A Edison of Menlo Park Middlesex County State of New Jersey. party of the first part and Gardiner G. Hubbard of Boston State of Massachusetts. G. L. Bradley of Providence. State of Rhode Island. Chas A Cheever of the City County and State of New York. Wilbourne L Roosevelt of the City County and State of New York. and W H Painter of Washington. district of Columbia. parties of the second part.

Witnesseth 1—

whereas the said party of the ~~first part~~ is the inventor of a new method for recording and reproducing therefrom the human voice and other sounds by causing such sounds to vibrate a mobile body the movements of which are recorded by indentation, displacement, subtraction from, or deposit upon any material and the reproduction of the movements of such mobile body by causing its record or a copy thereof to give motion to another or the same body and which is more particularly set forth in the specifications of his patent for which he did apply for in the United States

Patent Office December 15th 1877 and—
whereas the said parties of the second
part are desirous of engaging in the
business of manufacturing or having
manufactured and selling within the
United States of America the Phonograph
in apparatus and method invented by
the party of the first part for every pur
pose to which it can or may be applied
except to Watches Clocks. Toys of every
description
Therefore be it agreed that for and in
consideration of the sum of Ten Thou-
sand Dollars in hand paid to the said
party of the first part the receipt of
which is hereby acknowledged and for
other and further valuable considerations
stipulations and agreements hereinafter
set forth: The said Edison grants to
the said parties of the second part
collectively but not individually the
sole and exclusive license and right
to manufacture or cause to be manu-
factured and sell within the United
States of America only and for con-
sumption and use in the United States
of America only and not for export,
consumption or use in any foreign

country. The phonetic apparatus covered by the application dated December 15. 1877 as herein set forth. for every purpose to which it may be applied except Clocks and Watches and Toys. certain rights and licenses to manufacture and sell within the United States the said invention of the said party of the first part when applied to Clocks and watches having previous to this contract been granted by the said Edison jointly to Daniel H Bowers of the City County and State of New York and H J Haines of Brooklyn. Kings County State of New York a copy of which contract is hereto annexed and certain rights and licenses to manufacture and sell within the United States the Phonetic apparatus of the said Edison when applied to Toys for the use of Children. granted by the said Edison to Oliver S Rupell of the City County and State of New York previous to this contract a copy of which is also hereto annexed. which contracts rights and licenses the said parties of the second part hereby agree to except from and recognize as not herein granted to them the said right and licenses hereby granted to the said parties, of the second part and this contract is to continue during the existence

of the patent providing however that the said parties of the second part do separately or collectively within one year from the date hereof furnish for the purpose of the said business a capital of not less than Fifty Thousand Dollars to be used for the sole object of manufacturing and selling the Phonographic apparatus of the said Edison within the United States and to build up a permanent business in the manufacture and sale of such apparatus and the parties of the second part shall will and truly pay to the said Edison twenty per cent on the actual selling price of all apparatus or articles made sold or delivered and shall make true and correct returns under oath on or before the fifteenth day of each and every month of all sales of such apparatus made and sold or delivered during the previous month and allow the said Edison to have access to the Books and accounts at all reasonable times. It is expressly agreed and understood by the said parties of the second part that the main consideration to the said Edison in this contract is the twenty per cent royalty on the actual selling price of all apparatus containing the phonetic invention

of the said Edison to be paid by them the said parties of the second part to the said party of the first part promptly and at the time herein mentioned and that the sum of Ten Thousand Dollars paid to the said Edison as the consideration to the said Edison to enter into this contract and grant the exclusive privilege herein set forth to the said parties of the second part

It is known understood and agreed that the said sum of Ten Thousand Dollars is to be used by the said Edison to perfect the said Phonographic invention so as to render it of great practical value for many uses such as the reproduction of speeches and musical compositions. If the said Edison shall not within one year from the date hereof succeed in so developing and perfecting a satisfactory apparatus for dictating letters or reproducing musical compositions then and in that case the parties of the second part shall have the privilege of terminating this agreement upon written notice to the party of the first part to that effect and this agreement shall then cease and become null and void providing the said Edison shall at the time of receiving said notice or within fifteen days thereafter pay to the party of the second part the

sum of Eight Thousand Dollars ($8000)
In the event of the said Edison upon such notice failing to pay the Eight Thousand Dollars as herein above stated then and in that case this agreement shall continue in force the same as if said notice had not been given by the party of the second part. And it is further agreed that if the said Edison shall not return to the party of the second part Eight Thousand Dollars ($8000) as herein before provided for. the said party of the second part shall still have the right to terminate this agreement It is further agreed that they the said parties of the second part will use reasonable diligence in prosecuting and establishing a permanent business for the sale of such apparatus in the United States as herein provided. It is further agreed that if the said parties of the second part fail to render a true and correct monthly statement of all sales for each and every month during the continuance of this contract as herein provided after the manufacture and sale of the article has commenced or fails to pay the royalty of twenty per cent on the selling price of all articles or apparatus containing the invention of the said Edison

as aforesaid at the periods herein mentioned or do not use reasonable diligence in establishing and prosecuting the business of making and selling such apparatus within the United States then the said Edison shall have the right to terminate this agreement and it shall be null and void and all rights and licenses, and the said parties of the second part shall have no claims upon the said Edison for any money that may have been paid to him. It is further agreed that if at the expiration of one year from the date hereof the said parties of the second part shall have failed to furnish Fifty Thousand Dollars ($50000) for the purpose aforesaid then the said Edison shall have the right to terminate this agreement but shall have no further claim upon the said parties of the second part

It is further agreed that the said Edison will at his own expense protect as far as lays within his power the said invention from piracy or infringement and all improvements upon apparatus for the recording and reproducing of the human voice or other sounds except when such improvements relate to and are for specific use in telegraphy and solely adapted thereto and Clocks Watches and Toys aforesaid

which may be made by the said Edison within seventeen years from the date hereof and to come within the provisions of this contract and the said Edison is to receive the per centage before mentioned upon all articles containing said improvements. To enable the said Edison to receive a just and equitable consideration through the medium of the twenty per cent royalty to be paid him. It is hereby expressly agreed that the minimum selling price for each and every apparatus for the recording and reproduction of the human voice or musical sounds shall not be less than Eighty Dollars. but if at any future time it can be shown to the satisfaction of the said Edison that it would be advantageous to both parties to this contract to sell at a lesser sum or should any other person at any future time devices and apparatus for a similar purpose not an infringement of the invention of the said Edison and render it necessary by its competition in the Market to sell at at a lesser sum then the said Edison shall name a lesser sum to enable the said parties of the second part to compete with the said other apparatus with

profit but no discrimination in the matter of price shall be made between any Corporation or individual where such corporation desire to buy and use in their business and not for resale to others

In witness whereof we have hereunto set our hands and seals this Thirtieth day of January 1878

Witness
W K Applebaugh
for H.L.R. C.A.C.
G.G. H & T A E

Gardiner G. Hubbard
Hilbourne L Rosevelt
Geo L Bradley
Chas A Cheever

Witness
R W. Devonshire

W H Painter
Thos A. Edison

Menlo Park N.J. February 20 1878.

In consideration of services performed and to be performed by Chas Batchelor of Menlo Park N.J. in perfecting the Phonographic apparatus above mentioned, I hereby agree to pay to the said Batchelor his heirs or legal representatives ten (10) per cent; of all monies which I may receive from royalties from the sale of machines under the above contract, It being understood that under the above recited contract, the said Edison receives but fifteen per cent of the twenty per cent therein mentioned, he the said Edison being under contract to pay W H Painter of Washington D.C. five per cent of the said twenty per cent for services performed in obtaining such contract, It is understood that the said Batchelor is not to receive any part of the ten thousand dollars paid to the said Edison to aid him in experimenting. This Contract shall be binding upon the heirs or legal representatives of the said Edison

Witness { Wm. Carman

Thos. A. Edison

Laboratory of
Thomas A. Edison
Menlo Park N.J.

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This Agreement made the thirty first day of May in the year one thousand Eight hundred and seventy Eight, by and between the Western Union Telegraph Company party of the first part, and Thomas A Edison of Menlo Park in the State of New Jersey party of the second part

Witnesseth

First Whereas in performance of an agreement, made between the parties hereto and dated March 22, 1877, Edison has made certain inventions and improvements in Speaking Telephones, which are more particularly described as follows:

(1) An improvement in Speaking Telegraphs, No 130, as fully set forth and shown in specification dated April 18, 1877 and assigned to the Company by instrument dated April 18, 1877 recorded in U.S. Patent Office in Liber O 21 page 479 of Transfer of patents

(2) An improvement in Speaking Telegraphs No 135 as fully set forth and shown in specification dated July 16th 1877 and assigned to the Company by instrument dated July 16 1877 recorded in U.S. Patent office in Liber A 27 page 134 of Transfer of Patents.

(3) An improvement in Speaking Telegraphs

No 136 as fully set forth and shown in specification dated July 16, 1877 and assigned to the Company by instrument dated July 16, 1877 recorded in U.S. Patent Office in Liber A 22 page 133 of Transfer of Patents

(4) An improvement in Speaking Telegraphs No 143 as fully set forth and shown in specification dated August 16 1877 and assigned to the Company by instrument dated August 16, 1877 recorded in U.S. Patent Office in Liber A 22 page 306 of Transfer of Patents.

(5) An improvement in Speaking Telegraphs No 144 as fully set forth and shown in specification dated August 31. 1877 and assigned to the Company by instrument dated August 31, 1877, recorded in U.S. Patent Office in Liber Y 21 page 62 of Transfer of Patents

(6) An improvement in Speaking Telegraphs No 146 as fully set forth and shown in specification dated December 8. 1877 and assigned to the Company by instrument dated December 8, 1877 recorded in U.S. Patent Office in Liber M 22 page 36 of Transfer of Patents.

(7) An improvement in Speaking Telegraphs No 147 as fully set forth and shown in specification dated December 8, 1877 and assigned to the Company by instrument dated December 8. 1877 recorded in U.S. Patent Office in Liber M 22 page 37 of Transfer of Patents.

(8) An improvement in Telephone Calls No 152

as fully set forth and shown in specification dated February 28, 1878 and assigned to the Company by instrument dated February 28, 1878 recorded in U.S. Patent Office in Liber U 22 page of Transfer of Patents

(9) An improvement in Speaking telegraphs No 141 as fully set forth and shown in specification dated July 9 1877 and assigned to the Company by instrument dated February 28, 1878 recorded in U.S. Patent Office in Liber O 22 page 260 of Transfer of patents.

(10) An improvement in Speaking Telegraphs No 151 as fully set forth and shown in Specification dated February 28, 1878 and assigned to the Company by instrument dated February 28, 1878 recorded in U.S. Patent Office in Liber V 22 page 31 of Transfer of Patents

for which inventions and improvements applications for letters Patent of the United States are now pending in the Cases designated as Number 130 141 and 144 and such Letters Patent have been allowed for those described in Cases Number 135, 136, 143, 146, 147, 151 and 152

Second And Whereas it has been agreed between the parties hereto that instead of payment to Edison for such of said inventions as shall be patented, of royalties to be ascertained and paid in the mode

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and subject to the conditions provided by said agreement of March 22 1877 — the Company shall make the compensation herein provided for all the inventions and improvements mentioned in the first clause hereof as they now stand and for certain others — all as described in the fifth clause hereof: and that such compensation shall be paid during the full period herein named whether or not all or any of said inventions are patentable, whether or not letters Patent of the United States shall be granted for all or any of them and whether or not the Company shall ever use any of said inventions or shall at any time discontinue the use of any of them; and that all said inventions and improvements, and such Letters Patent of the United States, if any, as shall be allowed for any of them, shall be taken henceforth out of the operation of said agreement of March 22, 1877; and that that agreement shall cease henceforth to be applicable to them in any respect

Third And Whereas in performance of an agreement made between the parties hereto dated December 14 1875 Edison has made certain inventions and improvements in Acoustic Telegraphy being those described in Letters Patent of the United States issued

to the Company upon his applications and numbered serially 184.996. 185.537. 186.330. 198.087. 198.089. and 200.993 and also those more fully described in applications for patents now pending in the Patent Office, as follows, namely;

An improvement in acoustic Telegraphs No 132, as fully set forth and shown in specification dated May 8th 1877 and assigned to the Company by instrument dated February 25. 1878 recorded in U.S. Patent Office in Liber O 22 page 255 of Transfer of Patents.

An improvement in acoustic Telegraphs No 145, as fully set forth and shown in specification dated December 8 1877 and assigned to the Company by instrument dated December 8 1877 recorded in U.S. Patent Office in Liber M 22 page 35 of Transfers of Patents.

An improvement in acoustic Telegraphs No 148 as fully set forth and shown in specification dated December 15 1877 and assigned to the Company by instrument dated December 15 1877 recorded in U.S. Patent Office in Liber W 22 page 129 of Transfers of Patents

An improvement in acoustic Telegraphs No 148 as fully set forth and shown in specification dated December 15 1877 and assigned

to the Company by instrument dated December 15 1877 recorded in the U.S. Patent office in Liber W 22 page 129 of Transfers of Patents.

An improvement in acoustic Telegraphs No 180 as fully set forth and shown in specification dated February 13 1878 and assigned to the Company by instrument dated February 13 1878 recorded in U.S. Patent Office in Liber P 22 page 172 of Transfers of Patents

An improvement in acoustic Telegraphs No 173 as fully set forth and shown in specification dated August 18 1876 and filed in U.S. Patent Office of which invention there has been no assignment.

An improvement in Acoustic Telegraphs No 135 as fully set forth and shown in specification dated August 26 1876 and filed in Patent Office of which invention there has been no assignment.

Fourth And Whereas some of the inventions and improvements described in said letters patent and specifications named in the third clause hereof may be useful in connection with and for facilitating the use of the inventions in speaking Telephones and the other inventions mentioned in the First, Fifth, Ninth and tenth clauses hereof, and Edison has agreed that in consideration of the compensation for speaking Telephones provided by this agreement, he will demand of the Company no compensation for such value

of the inventions described in the patents and applications recited in the third clause as arises out of their use as aforesaid in connection with the inventions described in said First, Fifth, Ninth and tenth clauses hereof, which use Edison agrees that the Company may make.

Now in consideration of the premises and of the mutual covenants and agreements of the parties hereto as hereinafter set forth they respectively agree with each other as follows

Fifth

Edison sells and assigns and hereby transfers and conveys to the Company all his right, title and interest in and to all the inventions and improvements mentioned in the first clause hereof and in and to all his inventions and improvements in Speaking Telephones, as they in fact exist at the date of this instrument, even if they are not fully described in the specifications and assignments there recited and in all letters patent of the United States for them or any of them; and further hereby agrees to sell and assign to the Company all new inventions in Speaking Telephones which he may make before January 1st 1879 and also all improvements which he may make before January 1st 1879 upon any of the inventions and improvements described in this clause.

And Edison hereby agrees to make execute and deliver to the Company assignments in due and usual form, of all his right title and interest in and to all the inventions and improvements aforesaid sufficient to vest the full and exclusive title thereto in the Company and requesting the issue to it, as sole owner of such letters patent of the United States as may be awarded for any of them, and Edison agrees to accept the compensation provided in the Sixth clause hereof as full compensation for all the inventions and improvements described or referred to in this clause.

Sixth The Company agrees to accept from said Edison assignments of his right title and interest in and to all the inventions and improvements described or referred to in the Fifth clause hereof, whether they are new or useful or patentable or not, and agrees to pay to him Six thousand dollars in each and every year of the seventeen years next succeeding the first day of June in the year One thousand Eight hundred and seventy Eight. Such annual sum of Six thousand dollars to be paid in equal semi-monthly payments on the first and fifteenth days or on the first business days after each of said days in each month at the office of its Treasurer.

Laboratory of
Thomas A. Edison
Menlo Park, N.J.

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Seventh — Edison and the Company mutually agree with each other that all the inventions improvements and letters patent mentioned in or covered by the fifth clause hereof are henceforth taken out of the operation of the agreement of March 22 1877 and the said agreement ceases henceforth to have any application to them in all and every respect; and they hereby mutually release each other from all claims, demands and causes of action under said agreement of March 22. 1877 on account of any of the inventions improvements and letters patent last aforesaid

Eighth — Edison agrees that in any future appraisement under the agreement of December 14 1875 of the amount of compensation to be allowed to him for the inventions described in the third clause hereof, no allowance of compensation is to be made to him for any such use as the Company or its assigns may make of said inventions in connection with the inventions described in the first, fifth, ninth and tenth clauses hereof, nor for any such use just described as such inventions may be capable of (provided only, however, that

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such use facilitates or improves the practical operation of the inventions described in the First and Fifth Ninth and tenth clauses hereof.) It being hereby agreed by Edison that an account of this agreement and the compensation provided by it, he releases so much of the price to be allowed him under the contract of December 14 1875 as he would be entitled to for the value of such invention in acoustic Telegraphy when applied in the connection and to the use described in this clause, leaving the value of said inventions described in the Third clause, in all other connections and for all other uses, to be determined by the provisions of said agreement of December 14 1875 which is not modified or affected in any way by this instrument in any other respect than the single one mentioned in this clause.

Ninth Edison agrees that if at any time during the period of seventeen years fixed by the Sixth clause hereof, he invents any speaking Telephone or other apparatus whereby oral communication is conveyed over telegraphic circuits, which from its being based on a different principle, or from being constructed mechanically different, from any of the inventions mentioned or referred to in the Fifth clause hereof, shall avoid any patent for any of said inventions or improvements or which shall be capable

of being used without infringement of any such patent (provided however that such invention different in principle or mechanical construction shall have no such practical advantage over the invention covered by such patent as to make the new invention of any greater value than the invention already covered by such patent;) — he will from time to time as such inventions different in principle or construction as aforesaid and being without such practical advantage as aforesaid over the inventions covered by the fifth clause hereof may be made by him, assign and convey all his right title and interest in them and to the patents of the United States therefor to the Company without any other compensation than reimbursement of the cost of such invention to him — including the cost of experiments, drawings, models, materials and other expenses, not exceeding two hundred and fifty dollars in the case of each invention, which cost and expense the Company agrees to pay Edison, and it is mutually agreed by the parties hereto that as to all such inventions, different in principle or construction, as aforesaid all the provisions of the agreement of March 22 1877 henceforth cease to operate, but the provisions of the Eleventh Clause hereof shall apply thereto.

[11]

Tenth

And whereas the Company desires to secure all patentable improvements which may be made by Edison at any time during the period of seventeen years from June 1 1878 upon any of the inventions described in or covered by the Fifth clause hereof and also all new and other inventions in Speaking Telephones which he may make during the period of seventeen years from June 1 1878 but the agreement of March 22 1877 covers only a period of five years from that date; And whereas Edison is willing to secure all such patentable improvements and new and other inventions in Speaking Telephones to the Company for the compensation hereinafter in this clause provided which compensation is to continue in all cases, at all events, during the life of the patents which may be taken for the said improvements and inventions, but all provisions of the agreement of March 22 1877 as to royalties on patents and as to cessation of compensation paid in that way, and as to outright purchase of patents for round sums and as to re-assignment of letters-patent at the option of the Company, and many other of its provisions, are inconsistent with and are displaced by this subsequent agreement of the parties hereto as hereinafter set forth, in respect to such improvements and inventions made during during the period of seventeen years, and as to the compensation therefor:

Now, for the purpose of avoiding all

uncertainty as to the operation of said agreement of March 22 1877 in respect to the improvements and inventions which are the subject of this clause, the parties hereto mutually agree that Articles Third, Fourth, Fifth and Sixth of said agreement of March 22, 1877 have no application, operation or effect whatever on the said improvements and inventions, but it is hereby mutually agreed between the parties hereto, as to them, as follows:

Edison agrees that if at any time after January 1 1879 and thenceforth until the expiration of Seventeen years from June 1 1878, he shall make any improvement patentable under the United States Patent Laws upon any of the inventions mentioned in or covered by the Fifth clause hereof by which their value or efficiency shall be increased, or any other invention in Speaking Telephones or other apparatus, whereby oral communications are conveyed over Telegraphic circuits which may be used with such practical advantage over the inventions covered by the Fifth clause hereof as to make the new invention of greater value than they, the same shall be deemed to have been made for and shall belong to the

Company and Edison shall take all such steps to secure letters patent of the United States to the Company solely therefor, and shall do all the other acts in respect thereto which are provided for in the Eleventh Clause hereof; and immediately upon the issue of letters patent of the United States for any such improvement to the Company and after three months satisfactory trial thereof by it, it shall be the duty of the parties hereto to agree upon a compensation to be paid to Edison for such patentented improvement, and in case they are not able to agree together within three months from the date of such letters patent, and the completion of such trial by the Company, the matter of compensation shall, on the written demand of either party, be submitted to arbitration by two persons, one to be chosen by each party, and the decision of such arbitrators — or, if they are unable to agree, they shall select a third, and then the decision of two of such three arbitrators — as to compensation, shall be final and binding upon both parties; but it is mutually agreed by the parties hereto that such compensation, however fixed, shall not exceed the sum of five hundred dollars a year for the patent or patents granted in any one year, during the life of such patent or patents, and the Company hereby agrees to pay to Edison such annual sum or sums as may be fixed as compensation in any of the seventeen years

~~year for the patent or patents granted~~

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after June 1 1878 for the improvements and inventions described in this clause, in equal semi-monthly sums in each year of the terms of the respective patents for which they are awarded, and of the terms of all re-issues or renewals or extensions thereof, at the same days and place named in the sixth clause hereof.

Eleventh Edison agrees that all improvements or inventions made by him in the performance of the ninth and tenth clauses hereof shall be made for and shall belong to the Company and that he will promptly file in the patent office such caveats as may be necessary to protect the same copies of which he will thereupon deliver to the Company's attorney provided by the twelfth clause hereof, and will duly and promptly thereafter file his applications in the patent office for letters patent therefor, and will deliver to such attorney of the Company assignments of all such inventions to the Company, conveying to it all his right title and interest therein and requesting the Patent Office to issue all letters patent therefor to the Company as sole assignee and owner of such inventions,
and he also agrees to prepare all such drawings, models and specifications of his inventions in Speaking Telephones covered by this agreement as may be necessary to describe and illustrate them fully, and deliver the same, together with all sketches or memoranda

pertaining to them to the Attorney of the Company herein provided, and will at all times, upon the request of the Company or its said attorney, make, execute and deliver all amended specifications, models, drawings, or applications that it may require, and all new or other assignments that may be necessary to secure to the Company the exclusive title to all the inventions to which the Company is entitled by this agreement in their most perfected form, and also all papers required to secure re-issues, renewals or extensions of letters patent for any of them. And the Company agrees to pay the expense of all the things required to be done by Edison under this clause.

Twelfth Edison agrees to appoint and create by sufficient power of Attorney duly executed Grosvenor P Lowrey his attorney in fact, with power of substitution and revocation to said attorney and thereby give him sole and full power in the name and stead of Edison to prosecute all applications for patents made by him under this agreement, to prosecute and control all interferences and proceedings necessary or pertaining thereto which may arise in connection with any of the inventions or improvements described in this instrument; to prosecute and

defend all suits or other legal proceedings growing out of or connected with any of said inventions or letters patent thereof; and to do all other things which may be necessary to be done in any way to secure to the Company the full, exclusive title and benefit of all the inventions covered by the Fifth, Ninth and Tenth clauses hereof, and of all letters patent of the United States therefor.

And Edison agrees that upon the request of the Company, but not otherwise, he will revoke said power of attorney to said Lowrey, and will, whenever requested by said Company so to do, make, execute and deliver to such other attorney as may be named by it such power of attorney with the same powers as above described and will from time to time as he may be requested by the Company, but not otherwise, revoke such existing power to such other attorney as is herein described.

Thirteenth Edison agrees that he will at all times upon the request of the Company attend upon all interferences or other proceedings

instituted by or pending before the Patent Office, and upon the trial of all suits for infringements brought by or against the Company on account of any of the inventions or letters patent therefor covered by the Fifth, Ninth and Tenth clauses hereof, and will give his testimony on such proceedings and trials. And the Company agrees to pay to Edison for all such service a reasonable compensation for all time necessarily occupied by him in or about such proceedings or suits and will reimburse him all his necessary expenses incurred therein.

Fourteenth The Company agrees that all instruments or apparatus made or used by it during the existence of this agreement, which embody the principle of the Carbon disc shall be called and be marked "Edisons Carbon Telephone" and shall be so described in advertisements of such instruments or apparatus.

Fifteenth Both parties agree that this agreement applies only to the use and ownership of the inventions described therein within the United States, and to such letters patent therefor as may be granted by the United States.

Sixteenth The Company and Edison agree that all

the covenants and agreements made herein by them respectively shall bind respectively the companys successors and assigns: and the company agrees that what it has agreed to perform to Edison it will also perform to his executors, administrators and assigns, and Edison agrees that what he has agreed to perform to the Company he will also perform to its successors and assigns.

Seventeenth Both parties agree that the memorandum of agreement relating to Speaking Telephones signed by Edison and by the Company by Norvin Green President, and dated April 29 1878 is superseded by this instrument and is henceforth void.

In Witness whereof the said The Western Union Company has hereto set its corporate seal and caused its name to be signed by its Acting President and attested by its Secretary, and the said Thomas A Edison has hereto set his hand and seal the day and year first above written.

Signed sealed and delivered in the presence of

Note The words "Ninth and Tenth" interlined between the 28th & 29th lines on 7th page and the words "the invention" interlined between the 24th and 25th lines on 8th page all before execution

~~Wher~~

This memorandum of agreement entered into this into this first day of June Eighteen hundred and seventy eight by and between Thomas A Edison of Menlo Park N Jersey said Charles Batchelor of Menlo Park N Jersey Witness. The said Edison has by the within contract of which it is a copy been given a royalty of six thousand dollars per year for seventeen years from the date hereof payable semi monthly. In payment for the said Edisons inventions in telephones as herein set forth, And

Whereas the said Batchelor has given his time talents and attention is assisting the said Edison in bringing such inventions to practical uses. Therefore in consideration of such services by the said Batchelor to the said Edison the said Edison agrees to pay to the said Batchelor. Twelve hundred dollars in each and every year that the said Edison receive said six thousand dollars, ~~and in proportion for any lesser sum~~, from the first of June 1878 until the first of June 1895. If ~~by~~ by any chance, or process of law or otherwise the said Edison is not paid the said six thousand dollars then the said Batchelor shall receive nothing, or if the sum be reduced the sum paid the said Batchelor shall be reduced in proportion. This shall be binding upon my Executors assigns, or legal representatives,

from dollars to from scratched out Tr Edison

In witness whereof I have this day set my hand and seal.

Witness
S. L. Griffin

Thomas A. Edison (Seal)

Copy. W.C.

State of New York
City & County of New York } ss

on this eighth day of June in the year 1871. before me personally came Horace Green and A. R. Brewer to me personally known and known to me to be respectively. the President and the Secretary of the western Union Telegraph Company one of the individuals described in and who executed the foregoing instrument and the said Green then acknowledged to me that he was at the time of signing the said instrument. the President of the said western Union Telegraph Co: That the seal Affixed to said Instrument was the Corporate seal of said Company and was thereto fixed by him by order of the executive Committee of Board of Directors of said Company. and that by the same authority he subscribed the name of said Company to said instrument and also his own name as the then President: and the said Brewer then acknowledged to me that at the time of the execution of said Instrument he was the Secretary of said Company and had the custody of its Corporate seal: That the seal affixed to the foregoing instrument was the Corporate seal of said Company and was affixed thereto by the said Green by order of the executive Committee of the board of Directors of said Company and that by the same authority in attestation of the said seal and of such

affixing thereof. he the said Brewer signed his own name to said instrument as Secretary of said Company

Seal

Clarence Cary
Notary Public New York City & County

Copy

[FROM JAMES ADAMS]

THEO. PUSKAS

REPRÉSENTANT DE Mr EDISON
A L'EXPOSITION UNIVERSELLE
PARIS 1878

SECTION DES ETATS-UNIS

Paris le Aug 18th 1878

Chas Batchelor Esq

Dear Batch.

Telephones making quite a fuss there is three different parties after it. the only thing that I am glad of it that the telephone is worth fighting for and another good thing the price is away up. and I am very sorry that Edison undervalued the telephone for Europe Countrys. but if Puskas will do what he told me he would towards Edison, it will be all right anyhow. Puskas told me that all that he could get for it was 50.000 francs cash and just in stock. now Hog made an offer to Puskas of 100.000 francs cash for France & Russia and afterwards ~~the~~ 125.000 francs. it is true that Hog is not much of a man but he has got good men behind him, Hog only wanted to buy it for them and not for himself. that was what made Puskas mad at him because he thought Hog would make to much money out of it. he told me that if he let Hog have it for that money, he would sell it for not less than 280.000 francs. I told him I would not care. I would sell the Patents to whoever would give the most for it. so he said that is just what he was going to do and that he would get 150.000 francs for France alone. and that he was not going to con fine Edison to the amount agreed upon in contract

[FROM JAMES ADAMS]

but give him double what he expects, if he can command a big enough price for it. Herz said if he did not get the telephones from Puskas. he would try what he could do with Edison and if he could not get it from him at the same figures that he offered Puskas. he would law for it as he thought he had a right to it yet. but that is all humbuge he knows well that he cant do anything by law. had there not been so many after it it is my Honest opinion that 500000 francs would been all that we would ever heard of no matter what he got for it. but I know although Puskas did not tell me that 300.000 Francs, is his Price for France and I dont doubt but he will get it; he told me that if Herz tried to cut him out with Edison he would plank down the 40.000 francs agreed in contract immediately and that would fix all disputes. and then he could take his time to carry out his negotiations telephones is so much better than any magneto telephone. that it impresses everyone favorably the minute they hear it. I am having some experimental receivers made just now as I want to get as small a one as possible and do the same work. I think I can make one smaller than the Philips. and a magnet 3 times as strong as his. have you been able to kill the induction yet other wise than by putting thick diaphragm in receiver. I have struck something funny in that line. but I may be mistaken but wont say anything about it till I try further experiment or you might laugh at a fellow. Puskas wants me to go to Italy as soon as the telephones is of his hands here, once sold here there will be no trouble to go right through all the European Country there has been some Italians here that has seen it. and wants Puskas to come to with it as soon as possible. I will finish this letter in a day or two. as I must keep you posted about everything that I hear and know I have got enough to tell you to fill a newspaper. Jim

CHARLES BATCHELOR COLLECTION

LETTERS TO THOMAS A. EDISON

The following documents, dated April 5, 1878 through June 10, 1878 were found together in one folder.

Cat 1326

E5795-26

Cat. 1326

Suggestions to Edison on Phonograph & Telephone

about 1878.

Sacramento, California April 5th

Mr. Edison

N. York

Dear Sir,

You are undoubtedly bored by numerous letters that it will be impossible to answer them, but it is hoped you will not look upon this letter as one of that description.

You are (so is stated) afflicted with deafness and so am I, and as you must possess considerable knowledge in acoustics you are perhaps kind enough to give me some hints to overcome, my hearing by means of an instrument.

I have been studying Chemistry and Physics at the University of Leipzig (Germany) and in order to enable me to hear the lectures and make experiments I

them, I constructed an instrument about 5 years ago which I used for that purpose.
It is simply a large horn mounted on a stand and set before me, to the end
of the horn is attached one of those flexible tubes sometimes used by deaf perm-
and the small end is inserted into the ear being held by the little wooden
clamps to its place. The horn, stand & c with large is so arranged as to be taken
easily apart but in the pockets or suitable bag, and can be rearranged in a short time.
I give a rough sketch to the Scientific American N.Y. and they illustrated it at
the time, and I found on using the instrument to be of great value, but the observation it
calls upon the user (owing to its size) is not pleasant, therefore while at leisure
after lecture hours I experimented sometimes in preparing Collodion films as
strong as possible also gold beaters skin placing them at a and a' but on
trial found it obstructed the sound-wave because there was nothing behind the mem-
brane to convey the sound or vibration further while passing to be concentrated.
As I have no hope of my hearing being restored, and as I nevertheless "hunger" for knowledge
intending about July (this year) to start for Europe again to continue my studies at
Freiberg (Saxony) it is obvious in order to facilitate my studies that I have to rely upon
instruments to increase my hearing and therefore beg of you to give me some hint
(if they don't come in conflict with your future inventions) by which I may construct
an instrument by which I can greatly increase or concentrate the sound-wave.
In Germany previous to the discovery of the Telephone they hawked about the streets a simple
device which may be styled a telephone.

Simply consisting of two short tin speaking-tubes over which at a & a' some Parchment
Paper is attached with a long string (attached) placed ~~[illegible]~~ in the center of the

purchasing, and held by a thin metal disk.
I arranged a smaller horn or sectional similar to device described drawing the strings through the flexible tube so as to touch the ear and found there was no obstruction of the sound at the same time there appeared to be no material increase, I therefore concluded to ask your advice as a fellow sufferer.

While in Leipzig I had the scientific American sent to me and while you made the discovery of that peculiar electric phenomena which you subsequently applied to the "Electric Pen" I learned the numbers to Prof. Geo. Wiedemann one of the noted experimental lecturers in Chemistry and who has published a number of works some noted in Magnetism and electricity. He was much delighted to read of the discovery but thought it would never be of practical value which you have however proved otherwise. Leipzig when time permits you will oblige me with an answer or give me permission to call upon you while in N.Y. about July I am Most respectfully Yours

John Eitel

(Jas. Eitel)
Sacramento

Jno K.
~~STURGEON &~~ HALLOCK,
ATTORNEYS & COUNSELORS AT LAW,
in Patent Causes
~~Opera House Block~~
1 & 3 Penn Park Block
SOLICITORS IN BANKRUPT, PATENT, COPYRIGHT AND TRADE MARK CAUSES
ERIE, PENN'A.

Apl 10, 1878

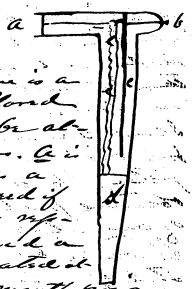
Prof. T. Eddison

Dr Sir

I take the liberty to address you and hope you will find time to answer. For a year back I have been pondering over some ideas that for lack of proper facilities I have been unable to experimental on. Your invention recently made public are in the line of thought somewhat that I have been following, and hence I write you. I know you to be capable of judging as to the feasibility of these ideas and I have no fear of trusting them to you. Being some what afflicted with lack of hearing I have thus had some of these matters thrust upon me. 1st Sound can reach the brain by other channels than the ears. Thus a deaf person can feel sound. So by placing a music box in his mouth and shutting his teeth

down on it he can feel the music or hear it as you please to call it. Therefore my idea is to construct a telephone by which a deaf mute can feel sound through the teeth. I suppose it will be necessary to augment the vibratory action of the diaphragm in some way. How to do this is the point I stick at. Can you, and will you suggest any thing. Will you please tell me what you think of my idea. One way I have thought of is to have a very sensitive diaphragm to take up the sound waves. This can through the office of an electric current acting as a motor produce equivalent vibration with accelerated power in a larger and more powerful diaphragm or sounding board or rod. On the next page I roughly sketch with my pen a form of device, for use of men being in a walking cane

STURGEON & HALLOCK,
ATTORNEYS & COUNSELORS AT LAW,
1 & 2 Opera House Block,
SOLICITORS IN BANKRUPT, PATENT, COPYRIGHT AND TRADE MARK BUSINESS.
ERIE, PENN'A.



The handle of the cane is a telephone, at a a flored piece or funnel may be attached on occasions. a is the diaphragm, c is a sounding board or reed if you please. e may represent the wires and a battery may be located at d. b is the tet or mouth piece. Would the thing work. Is any Electrical apparatus necessary? Tell me what you think of it.

2nd As to your phonograph. Do you suppose it would be possible to make a set of diaphragms each of which is sensative to only certain sounds. If so it will be very easy matter to print a short hand kind of reading. That is make a legible sound writing. Thus if one diaphragm

can only vibrate when the sound for which the stenographer makes a certain kind of "quirlequin" is made, and another for another then it will be easy through an electric arrangement which I cant here in the space explain but which you will easily conjecture, to make the motion thus obtained print by a type in letter of any alphabet, that sound. It would be a regular Josh Billings style of orthography but it would do. This idea came to me while operating a telephone about a year ago before I heard of your wonderful yet simple phonograph but it took an Eddison to get at the boss thing. As to the possibility of making such a set of diaphragms. I must say I doubt it — But an Eddison may be the "feller" who "can find out" so I submit it to you —

I hope you will be so kind as to answer this, and oblige —

John K Hallock

Office of JAMES W. SEE,

MECHANICAL ENGINEER.

Office: Opera House.

Hamilton, O. Apr 12 1878

Mr Thomas A Edison
Menlo Park
New Jersey

Dear Sir.

I have allowed myself to be guilty of an invention in the way of an autographic telegraph. No intermediate processes about it, the message being transmitted simultaneously with the writing. Am now posted as to the state of the art and know that autographic transmission has never been attempted in my way. It is possibly purely a device a single instrument being used.

What's all this to me? you say? — Listen. My professional work presents my putting the thing in shape to yield results, you dont do any thing else. If you are disposed to take hold of the rig I have this proposition for you.

I send you drawings & specification of the institution, will place the thing entirely in your hands for development and intro-

2

Office of JAMES W. SEE,

MECHANICAL ENGINEER.

Office: Opera House. Hamilton, O. 187

duction. The patent and its results to be mutual. This refers to U.S. only as all the European patents are disposed of and a London firm is now working on the beast. A London Electrical Engineer took hold of the thing for this firm and in 3 weeks died — maybe thats what killed him. His successor is now grinding at it, how much progress I cant say, haven't heard for a month.

Study on this thing and if you feel disposed to accept my proposition I will send the papers as soon as I can get copies made.

I am interested considerably in the phonograph, and want to make a suggestion as to the construction of the bird.

As you make the machine, the normal position of the point is just below the level of the foil surface. As the diaphragm is

3

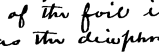
Office of JAMES W. SEE,

MECHANICAL ENGINEER.

Office: Opera House.

Hamilton, O. 187

distended in vibration the point goes deeper.

Now when you come to operate the point by means of the foil it is obvious that as long as the diaphragm occupies its normal position it will skip the valleys it has formed, thus  the normal line. If you now set the diaphragm closer so as to have a new normal, corresponding with the deepest valleys, something will be wrong for the vibrations will act upon the diaphragm and distend or vibrate it in a direction opposite to that which it worked in when receiving its impulses from the air. This will be bound to neutralize the sound by producing vibrations not like the vibrations fundamentals. I would suggest the experiment (maybe you have tried it) of talking to the backside of the diaphragm which is to be set deep enough to allow for the highest prom-

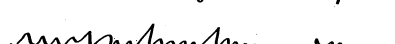
4

Office of JAMES W. SEE,

MECHANICAL ENGINEER.

Office: Opera House. Hamilton, O. 187

inches. The normal line will then be at the bottom of the valleys thus



I have a faint suspicion that if air be kept from reaching the back of diaphragm, the machine will not tack at all.

— These suggestions may be impertinent but remember how cheap they are.

Yours Truly

J. W. See

Formerly of the Firm of
HOSKINS, CLARK & SIDDLE.

J. P. CLARK,
MANUFACTURER AND IMPORTERS' AGENT
FOR THE SALE OF
WATCHES, DIAMONDS, JEWELRY, ETC.
920 CHESTNUT STREET, 2d Floor.

Philadelphia, April 14th 1878

Prof Thos Edison

My dear Sir

I am about to inflict on you a Statement which I beg of you to read and consider strictly confidential although it may be, to you, uninteresting. I will enclose it with this that, when in your Laboratory at Menlo Park, at the time you complained of the "Chattering" of the Phonograph, my impression was & is now, that it was owing to the point being rough and traversing the foil again would not run smoothly. That was the reason I recommended the "Screw head tool" which I

2)

presume you have tried. I wish I had stopped longer & made more acquaintance with Mr Batchelor (who I was glad to notice was so successful here, in what I suppose was a sort of test case of the two systems of telephones,) as I would like to try another "do it" as he calls it on that hand organ with him. I noticed you in "stoning" the point with a small slip of Arkansas stone. You cannot possibly make it entirely smooth in that way. Also the Gentleman who recommended a "diamond" point I think was mistaken as I believe that would be too sharp, as polish on a diamond will most always leave some cutting edges. A Ruby or Saphire would probably be better but I think if you use the tool

3) purchased in New York, first, with a slip of Arkansas stone, to round your hard steel point, and then "diamantine" (of which I enclose a [redacted], but enough to polish a thousand points, and it is the quickest most working material for glossing which I have ever seen) you can in a moment get the finest black polish which I think will wear as well for the purpose as any stone and you can without taking it out of the instrument (the point) again, repolish it instantly

The best way to apply that, would be to put a small drop of clean oil on a flat piece of steel & enough "diamantine" to make a soft paste. Then a very little on a piece of hard, fine grained wood, or a small bit of sole leather, anything will answer which will hold it and very little is required. If you keep it clean the amount I mention will last a long time and you will find it very quick working which I know will suit you. Excuse the length of this & believe me

Most respectfully, yours J. H. Clark

309 W. Washington St.
Chicago Apl 15/78

T. A. Edison Esq.

Dear Sir.

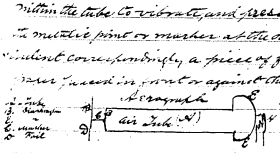
Your life and mind achievements read like a romance, but if there is one thing more remarkable than another it is this – that the inventor of all these wonderful machines lives to enjoy as he goes along the success, wealth and fame attending his discoveries.

Yours truly
M. C. Spaulding

P.S. Should you find time for any more experiments please test the efficiency of what for want of another name might be called the Aerograph an apparatus for transmitting and

recording characters signs or letters by means of the pulsations of the air.

Take a tube of rubber or metal 2 or more feet long. Close each end of this tube with a piece of rubber or pliable leather. or Stiff paper may be pasted over the ends so as to inclose the air. To the center of one cover or diaphragm attach a metallic point or marker. Then beat, or play, with the finger on the other end - this will cause the air within the tube to vibrate, and press outward the metallic point or marker at the other end. Indent correspondingly a piece of foil or paper passed in front or against the marker.

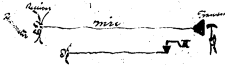


By enlarging the Rubber Cover "E" at one end it would bring more air space to bear upon the tube and the compression of "E" with the hand or otherwise would send the vibrations to a greater distance and make the characters imprinted by the marker more distinct. The Horse or other Alphabet could be employed - and if the air tubes were long and large machinery could be used to compress the air lightly or forcibly according to the effect desired -

This apparatus might be applied also to force the air through reeds or musical pipes and language be thus transmitted.

Have you ever Experimented to ascertain how far sound can be sent along or through an ordinary telegraph wire - Under favoring circumstances sound is said to travel 1100 or 1200 ft a second or at the rate of about 4 1/2 seconds to the miles. To what distance can the Click stroke or concussion of a hammer upon the end of a telegraph wire be distinctly heard. For short distances, I can conceive how a kind of telegraphing may be achieved without the aid of Electricity, by simple mechan

Sonodult . Sonoscribe Sonoscript



Cal Concussion or vibration of a wire.

Attached to the receiving End of the wire should be an Ear piece or a phonometer - while to the other end is fastened a steel knob or knob on which the sound for transmission through the wire are produced. 4 two telegraphers can carry on conversation at table by thrumming on their plates - they can do it more successfully through the medium of a wire - in fact the success of the telephone is nothing but the ~~[illegible]~~ vibrations of the voice through or along the wire.

Does the voice penetrate the interstices of the wire or ~~[illegible]~~ is a jar to one particle transmitted to another and so on along the entire series of particles Composing the wire, Pardon me for trespassing upon your time I conclude by wishing you Continued success health happiness and fortune - Respectfully yours

Both your suggestions are [illegible] Prodigy

practically, [illegible] that I have used ~~[illegible]~~ on your paper the second has been tried on Mr Bell the voice by [illegible] [illegible]

President, Chas. F. Muench. Office Treasurer, Nathan Hilles.

Citizens Gas and Gaseous Fuel Company,

Cor. Third and Chestnut Streets,

Harrisburg, Pa., April 15th 1878

Thomas E. Edison Esq

Allow an old inventor to address you on "big" — I have worked out the problem of increasing the volume of sound in your "Phonograph". Can furnish specific details. the impressions from the metalic disk are enlarged and are made upon a rigid material suitable to operate the toe of valve lever in your Compressed air Phonograph or Airsphone. If you want my device I am open for a deal. I will prove the idea to be feasible and practical besides it is simple. — Am a practical machinist and inventor. I have a telephone working here that can be heard. (Singing and playing of Piano) twenty feet from instrument. If the above is of interest to you lets hear from you.

Wm P Patton

Supt. C. G. and G. F. Co

Suggestion from other on the Phonograph

Philadelphia
April 16 1878

Thomas A Edison

Dear Sir: I notice you use tinfoil on your Phonograph, would not the thin tin enclosed be better, it would last longer in use, and be less liable to tear

If the Phonograph has not power enough to indent it could you not use an electro magnet with Morse lever and point using the diaphragm as a circuit closer, or, if the sounds produced depend on the depth of the indents as well as on their distance apart, and the using of a battery is an objection, use the same kind of magnet as used in Bells telephone, making

it large and powerfull enough

The specimen I send you is hard and brittle from rolling perhaps you can use it without annealing. I am not sure it is not tinned iron plate

Yours
Frank Foell
1120 Carpenter St
Phila

Middletown Conn April 17th 78

Thomas A Edison
Menlo Park N.J.

Dear Sir

I dont propose to bore you by writing a letter when I've nothing to say. You are undoubtedly annoyed sufficiently by bores since you struck the magnificent Phonograph. I am by nature and experience something of an inventor. I read with the utmost interest everything I see about your late inventions. If the Phonograph can be made to do perfectly what it attempts I consider it the greatest invention of modern times. I have never seen it - I have just read that it will render piano music in about one fourth its original volume. Can you not increase its power? Perhaps you have tried what I am about to suggest, if so and it wont work dont laugh at me - How will it do to make the vibrating disk in the recording instrument three or four times (perhaps) larger than that in the repeating or rendering instrument, so that its vibrations will be greater and the impressions in the matrix made deeper. If that wont do would it not be a good plan to have the music &c to be recorded, produced in a room made air tight and filled with

compressed air of a few pounds to the inch - as the sound waves would then be stronger than in ~~an~~ single volume of air -

If these suggestions should be of any use to you I shall feel amply repaid for making them. You see I am selfish for I mean to become possessor of one of your Phonographs - and I want it to give me music in all its fullness and volume as originally produced -

With the utmost respect &c I am
Yours truly
A W. Johnson.

A W Johnson
Nov 7

Dear Sir:

Your first suggestion is not very good the volume is increased but the articulation is bad the second one is good & is the only way I have succeeded in getting down Orchestral Music, Small Room Large Collector & almost air tight - Many thanks for your Communication Yrs
Yours

Camden Letwe Segment

(1878)

Philadelphia 4-22-78

Sir

Happening to be in the neighborhood of third (3) & Chestnut Sts some time ago & having heard your Phonograph spoken of by some gentlemen on a previous occasion, I went (in order to satisfy my curiosity more than any thing else,) into Mr. Bentley's office & heard a rendition of a reitteration of words spoken into the instrument by Mr. Bentley & a young man who was in the office; Being a Student of Phonics, & having a practical knowlege of the same, I threw my self into an attitude-erotic, & noticed that some of the vibrations did not issue from the Phonograph with the distinctness, (especially the aspirates & Lipaels,) as other did (Vis Vowals dentals guterals &cc) & having in former experments discovered that a vessel shaped like the drawing (marked xx) with a thin diaphragm (marked xxxx) would take up & expel sounds (either (noise or music) more readily than any other shape. I thought it could be utilized in transmitting the vibrations from the tin-foil, a form of this ~~thing~~ kind acting the same as an lens in a telescope, by bringing the vibrations to a focus thereby concentrating & intensifying them to an unlimited degree & after being focused the vibrations would gain surprising,

volumn by being scattered, by a gradual funnel like the drawing (marked xxxx), having discovered this point before the Phonographs had been made public by exhibitions, I made a note of it & allowed it to rest, until one Sabbath Morning while taking down a sermon in one of our Philadelphia churches I thought of utilizing it, by making in connection with the vocal lens & funnel and attaching to the diaphragm a complicated lever of the 1st & 2nd Order, having attach to the end of it a pen or pencil which was to trace the vibrations upon a strip of paper being drawn over a rest like the drawing (marked) from a reel having a brake attached to a reel having attachment to clock work & thereby obtaining an automatic reporter which I thought would be easier than writing Phonography (of course the tracings would would have to have been analyzed & studied before becoming of practical use) & when I heard the Phonographs defects, I thought a similar instrument (excepting the lever & using a point) would obviate the difficulty; not having the means (pecuniary) to perfect the plan I thought by submitting it to you it would be a benefit to the public in general; now to the business part which is only a few word, is if you can utilize this don't forget me

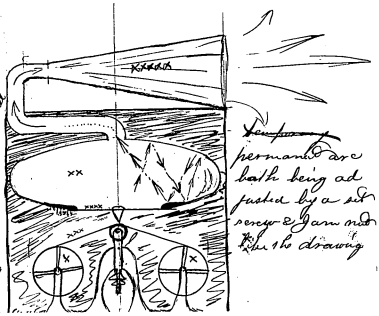
Scientifically Yours

Henry Clay
672 N. 10th St
Philadelphia
Pa.

To Mr. Edison

[ENCLOSURE]

by following the arrows ~~we~~ you see the way in which the vibrations are concentrated & intensified the rest either a ~~rec~~ a pulley having a groove turned shit or a



~~Temporary~~ permanent arc bath being adjusted by a set screw & Jam not like the drawing

Adams Express Company,

Boston, Mass., April 22d 1878.

Thos. A. Edison, Esq.
Menlo Park, N.J.

Dear Sir, A friend described to me the working of one of your phonographs now on exhibition in New York city, and mentioned the trouble taken and loss of time incurred, to get the drum holding the tin foil back to its starting point, so as to reproduce the recorded sounds. My object in now addressing you is to suggest an improvement that may overcome the delay, and ensure the placing of the barrel or drum at the initial point.

I suppose the spindle or axis of the barrel is supported on two bearings, one of which is a female screw, the other smooth. If so, cut the female screw in two, horizontally. Then when the barrel is to be carried back to the starting point, raise or tip back by a hinge, the upper half of the female screw, raise the axis from the lower half and slide it back to the starting point, which can be known without trial by having a projecting

Adams Express Company,

#2 Boston, Mass., _____ 187

pin in the smooth part of the axis, still the smooth bearing or journal of said axis. To allow raising the screw end of the axis, the smooth bearing or journal can be placed so as to rotate.

Trusting I may soon have the pleasure of seeing one of the machines in Boston, I remain

Yours truly

Edw L. Adams

Washington D.C. April 23rd 1878

Thomas Edison Esq.
Dear Sir:

I made several efforts to see you while you were in Washington, but without success. I learned from Mr. Painter that you might not return for some time, so I concluded to write my business to you.

I have lately obtained a patent on a method of transmitting diagrams by telegraph, which has been tested by the War department and received a favorable report from the Board of Examiners to the Sec'y of War — Arrangements are now being made for its adoption by the Signal Office — I have for some time been working on a modification and improvement of the instrument, which when finished will make it invaluable for universal use, not only in transmitting diagrams, but also writing &c. I have not however the facilities for completing the thing here and it occurred to me that, perhaps you might in consideration of a fair share of the honors & profits be inclined to take hold and help me to perfect it. If the transaction is in your line, please answer at your earliest convenience, so that I can explain matters and let you judge of the practicability and value of the improvement

Very Respectfully J. M. Wolbrecht Room 3 St. Cloud Bldg.

MASON, FENWICK & LAWRENCE,

American & Foreign Patent Agents & Attorneys:

OFFICES: { CORNER OF F AND 8TH STREETS,
Opposite U. S. Patent Office, and Post Office Department.

Washington, D.C., April 23 1878

Mr. Edison

Dear Sir,

In your "Phonograph" you use a Steel Disk: Permit me to suggest that a disk made of Chinese Gong metal would develope far greater vibratory power.

I am your kind

D. C. Lawrence

have tried Gina Mills Somas which is [illegible] [illegible] for talk

Form 1251.

American Dist. Telegraph Co.,

NEW YORK.

EXECUTIVE OFFICES
62 Broadway,
Messenger Department,
33 & 35 BRIDGE ST.

SUPERINTENDENT'S
AND
Auditor's Offices.
516 BROADWAY.

New York April 23 1878

T A Edison Esq

Dear Sir

I wish to call your attention to an improvement in the Phonograph which has been made by a friend of mine (a professional inventor) who wished me to lay the matter before you. He claims that by his method you can use thick sheets of brass or steel for receiving the impressions of the vibrating diaphragm. This would be a great improvement over tin foil or soft metal as if a hard brass or steel surface can be employed it would make the impressions almost as permanent as time itself. He employs a small steel drill which revolves with almost

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..... 187

inconceivable rapidity. The vibrations of the diaphragm propel the drill against the ~~surface~~ surface of the brass or steel plate & deep or shallow holes are bored according to the energy with which the diaphragm is caused to vibrate. If you would like to see his drawings & hear his explanations I would take pleasure in introducing him to you.

His apparatus is now in process of manufacture

Yours &c
James E Browne
192 Broadway
Room 8

I have a while [illegible]
does not seem to [illegible] [illegible]
[illegible] [illegible] [illegible]

Washington, D.C. April 25/78.

Thomas A. Edison, Esq.
Menlo Park, N.J.

Dear Sir:—

Introducing myself, as one of the many admirers of your brilliant inventive genius, I take the liberty of intruding upon you, begging an opinion, as to the utility—if any—as to an idea that has impressed me of the possible application to the Phonograph or Telephone, as a sound collector, the conch, or the principal of its construction. I may merely mention in connection with the idea, the old superstition of being enabled by its application to the ear to hear the ocean-storms approach.

In a brief experiment a few evenings since, at a friends house, who possessed a collection of shells, we found on applying the shell to the ear a greatly increased distinctness in the voices, even when subdued to a whisper almost, of those present

87 South Pond Apr 25

at the other end of the room. The shell we used is known, I think, commonly, as the "milk conch."

As, give this suggestion a thought - might not the principle be usefully applied in assisting the hearing of the deaf?

Very truly yours,
S. H. Sutherland
Draughtsman Division
U.S. Patent Office

New York
April 25/78

Prof. T. A. Edison
Dear Sir

I have an idea in which I think there is money, but cannot perfect it without your aid. I am advised by one of your friends to present my ideas for your consideration and that you will aid me if you can or give me your opinion as to its success or failure.

I wish to manufacture and place on the market a simple and inexpensive instrument for boys to learn Telegraphy. Will not the Alphabet wheel in

your Stick Indicator answer the purpose, or will you inform me of something better and less expensive. I am willing to make any disposal of the profits that you deem fair and equitable I furnishing the money for advertising and placing it in market.

An early reply will greatly oblige

Yrs Very Respy

J. C. Linton.

W A Haight
Apr 26. 78

New York
April 26th
1878

Mr Edison – I send you a very remarkable "Idea" for your inventive genius to work upon, not really more extraordinary than the Wonderful Telephone and Phonograph – but one which may be made use of by the many – being so inexpensive I merely send to your honor and generosity – should you succeed in carrying out the Idea –

I believe Clairvoyance to be the "Gift" spoken of by the Prophets – as God the Lord Jesus Christ Spirit being poured out upon many in the latter days – and

file suggestions

when I read of your powers I thought "He is only glorifying God - it is the gift of the Spirit of God the wonderful - the Miracle worker -

I have seen such strange visions - known of such prophetic wonders during the last 15 years in my own family - have had such revelations from God that when I hear of the power given you - I truly hope and trust, you honor your Saviour, by humbly attributing all power to Him -

That you may also be a partaker of His Holy Spirit of meekness and fruits of gentleness and kindness as a return for His Bounty to you is the wish of your Correspondent

Mrs A. Haight
20 West 37th St
New York

I have such love for Invention - that I had to write to express myself with delight over the Wonder - and if you have time - and are in the City any afternoon you will most likely find me at home -

have also a written article copied from another paper on this subject to show you - at a personal interview -

Boston
Hotel Berkeley
Apr. 27. 1878

My dear Sir.

I received yesterday from Mr. T. N. Watson one of the hand Phonographs with which I am now experimenting, its use only confirms the opinion that with the more accurate clock work instrument we shall have a most valuable means of studying the vibrations resulting from the production of articulated sounds. Such investigation methodically carried out must afford a basis for the further improvement in the articulation of the Phonograph.

The mechanism of the human ear has been made the subject of minute and careful study and by availing of this much time may be saved and many empirical experiments avoided.

I have a preparation of the drum membrane of the human ear. one of those which I have been

using as a Telephone, which is at your service. but I should be happy to explain more minute point of importance about it which are of interest in connection with the Phonograph. and concerning which you would probably have many questions to ask.
The sound transmitting apparatus of the human ear is the most delicate mechanism for reception and transmission of a wide range of musical tones of which we have any knowledge. and the principles which govern its vibration must therefore form the basis for any mechanical device having this object in view. These principles form the basis for any mechanical transmission of sound waves

I have thought of leaving Boston next Saturday night, and bringing the ear preparation with me to pass a part of Sunday and Monday with you at Menlo Park. If however you are soon coming to Boston I hope that you will arrange to devote a part of a day to what I may be able to explain to you of the mechanism of the ear.

In regard to the better effect which you get from "damping" the Phonograph disk by pressure on the outside it seems to me that this is due not to a diminution of the vibration of the disc as a whole but rather to increasing its power of return under very slight impulsis. (thinning out the sharper overtones of the disk)

In speaking against a flat Phonograph disk you move it in one direction, toward the tin foil, and

must depend solely upon the elasticity of the disc for the return half of the vibration. (Fig 1) Now by pressure on

the outside of the disc by means of stuffing paper, or rubber under the mouth piece you bend the disc forward in the form of a bow as it were and increase its tendency to spring backward (Fig 2) thus facilitating the return half of the vibration. By placing a small piece of rubber under the mouth piece close to the edge of the opening, I get better results than with a less elastic

material. I believe in very place you may be sure to experiment with the clock work Phonograph, since as ~~they~~ experiments with the human ear gave the first clue to the Bell Telephone shall hope that they may prove of service in the development of the Phonograph. Very truly yours

Clarence J. Blake.

Boston
Hotel Berkeley
April 29. 1878

Dear Sir.

In a recent communication to the Royal Society as well as in a previous communication published in "Nature" Prof. Jenkin of London says that the Phonograph controverts the Helmholtz theory of vowel sounds. – On the other hand experiments made by Prof. Cross and myself serve to confirm the theory of Helmholtz – for instance: The revolution of the Phonograph cylinder being timed by a second pendulum and rotated first at the rate of one revolution a second the vowel sound O was several times repeated into the Phonograph. On retracing at the same rate the vowel O was of course repeated but on increasing the rate of rotation to two revolutions in a second.

the vowel sound Ee was given out and on increasing to four and six revolutions a second, (approximately) the vowel sounds E and i were given forth. On diminishing the rate of rotation to ½ revolution a second the low vowel sound ah was given forth. - furthermore - the cylinder with fresh foil was rotated at the rate of one revolution in a second and the vowel sound O sung into the phonographs repeatedly covering the whole strip. on retracing at the same rate the O was clearly reproduced. but by beginning at the rate of ½ revolution in a second and gradually increasing the speed all the vowel sounds were reproduced from low ah to high i - thus confirming it seems to me the Helmholtz theory of vowel sounds in relation to pitch.

A clockwork movement for the phonograph so arranged that the cylinder may be made to revolve at different rates of speed would of course much facilitate this and similar investigations. I may be going over what is already old ground to you and repeating experiments which you have already tried if so please pardon me on account of my interest in the matter and I will talk henceforth into one of your "boring machines"

By covering the cylinder with a layer of very thin pure rubber tissue and putting the tin foil on top of that I find that in addition to distinct articulation I can get a better reproduction of the s. sh. and ch. sounds.

Very truly Yours
Clarence J. Blake

T. A. Edison Esqr.

Boston
Hotel Berkeley
April 30th 1878

My dear Sir,

Since my note of yesterday I have concluded another experiment with the Phonograph.

By following the course wh. I proposed when I saw you, and constructing a disc on the principles governing the vibration of the human ear I have succeeded in diminishing the hissing and scratching noise upon the tin foil and in nearly doubling the loudness of the articulation. The sharp overtones due to the individual vibration of the plane metallic disc are also largely done away with.

and in consequence of the corresponding prominence of the slighter overtones the voice is rendered more mellowed in quality. If you are to be in Boston next week for the meeting of the American Academy of Arts and Sciences I will endeavour to have a disc ready to place at your disposal, in the mean time if you can spare a moment from the many calls upon your time I shall be very glad to know what you have done in this direction.

If you are to be in Boston for a day or two we may be able to go over the preparations of the case, of which there are several. in case you can spare the time from the other duties which you will have here.

Very truly yours
Clarence J. Blake

T. A. Edison Esq.

I hope that you have found time to see Dr. Agnew.

Private) New York, May 1st 1878

Dear Sir:

Fear of being convicted of impertinent intrusiveness has deterred me from writing to you before — as doubtless too many have about the abilities and requisites of the "phonograph" — every tyro is anxious to instruct the "Court in law". Still, being solicitous to aid in increasing the methods and general average of practical education — a pursuit to which I have devoted myself for some years in my narrow way — I am therefore anxious to have the phonograph a speedy fixed and common fact.

This I assume chiefly hinges on the possibility of duplicating ad lib. the dented phono-type, and in the further possibility of the phonograph to make readable marks. On the latter point I desire to present to you some facts and suggestions not in the "books".

I think any scrutiny of phonograph-ic writing after distinct radical signs for single sounds will be useless, except for the independent or "vowel" sounds, as ai, ee, I, O &c. The next advanced independent element of English words is the articulation consisting of a fused vowel and consonant; an ending articulation as ad (vowel ended by consonant) and a continuant one as da. Independent elements will alone be likely to have radical marks in a mechanism

registering phonetically. Therefore I submit to you the ~~following~~ enclosed table embracing in a related manner all the simple independent elements of words in English; the series of vowels ~~being~~ is given at the top of the columns, each column being a series of consonants articulated with the same vowel, while each line is a series of all the "common vowel" articulations of any single consonant. (The three special vowels and their chief articulations are given in a note to table.)

To investigate the power of the phonograph to register vowels and articulations, repeat into the phonograph the first series of articulations of any thin consonant, as those of T, at, et &c then repeat the corresponding series of the related dense sound as of D, ad, ed &c; an inspection of the uniting will then test the degree of uniformity the consonant preserves with the varying series of vowels, also the degree of variation there is between the related thin and dense sound. In this way the alternate continuant series of T and D should be tried, da, le, &c and da, de &c. Then the scales of P and B, of K and G, Ch and J &c. Whether the result is or is not satisfactory the process should be reversed to discover the peculiarity of mark of each vowel with a varying consonant by repeating into the phonograph the series of articulations in each column, first repeating all the ending articulations as at, ad, ap &c then all the continuant ones as la, da, pa, as in ta-p da-p, pa-p.

The power of inscription due to peculiar tone and force of voice is a special matter unlikely to be overlooked by a careful investigator. If there proved to be some fair result from this simple articulation ~~test~~ investigation, then it should be carried to the union of two diverse articulations as da-ad into bad which is the only other form of sylable besides the vowel and the single articulation. The point of investigation being to see how far the addition of an ending consonant (as ad) affected the form of the continuant as ba. This full sylable practise can be carried on in word groups that can be readily thought out. ~~by~~ First repeated into the phonograph a series of either ending or continuant articulations as ad, ed &c or da, de &c, then if the ending series is used mentally recall and associate the series of continuant consonants with ~~the series of~~ ending articulations of any selected consonant as t-ad, d-ad, p-ad, bad ch-ad, j-ad, c-ad, g-ad, n-ad, m-ad, th-ad, dhad (that), sad, zad, fad, vad, shad, zyad, lad, rad, ~~wad~~, yad had, whad, wad.

Then form + scribe another A sylable group by prefixing the same continuant consonant to the series of ending articulations of any selected consonant as t-ad, t-ed, tid, tod, tud, tade, teed, tawed, toad, tood tide, toyed, toude,

Finally add the series of ending consonants

to a selected continuant articulation as ta-t, ta-d, ta-ck, ta-g, ta-p, ta-b, ta-ch, tay, tan, tang tam, tath, —, tass, taz, taff, tar, tash, —, tal(low) tar(ny),

This related practice will give all the related changes of like sounds, wherein two sounds are invariable all the time, ~~and~~ if the series of compound consonants are used with the respective ending or continuant series of consonants, these word-groups can include the whole single, compound and double articulation possibilities of the language (though the table shows many articulations to be wanting still some named are not in word-use and others are very infrequent).

The attached schedule gives all the compounds of consonants in English words and these can be scaled like simple consonants as Continuants fra, fre, fri, fro, fru, frai, free &c, or its ending ats, ets, its, ots &c. Introducing compounds in the full syllable groups will be one way of testing compounds, it can also be done by repeating a compound's scale after its leading single consonant scale and then the scales of the related compounds as fa, fe &c then fra, fre, &c; then fla, fle, &c. It is as easy to recal the compounds as it is to state the articulations of any consonant, if it is once noted that a few sounds in peculiar but general ways are the fusing elements.

The mating or doubling of vowels can also be scaled at will for vocal testing by stating the series of common vowels after any selected long vowel or after the short vowel e: thus,

O-a (co-alesce) O-ai, (co-heir) O-e, (Owen) O-u (go-up)
O-o (co-oper) O-O. (co-owner) O-oo (so-ooze), O-I (so-I)
O-i (ow-ing) O-ee (show-y).

These unknown facts for the sake of brevity perhaps only vaguely explained, detail the whole material used in all classes of English words and exemplifies the order and variability of the use of the little vocal material that results in an endless verbal variety, which I have tried to present free from theoretic or mystical views that make so much that is printed to aid lingual study primary or advanced the reverse of useful. In the department of education and of relating to the use and study of language I am anxious to see what is practical and positive take the place of what is tedious and roundabout. I hope to effect something that way, if I have not yet done so materially, but I feel that your phonograph invention, once fairly perfected will have the most potent effect in making education universal with a constantly expanding degree of human intelligence therefore if any of these suggestions may expedite or direct something pretending to lighten the serious problem I think you have even yet in hand I shall feel pardoned for troubling you with such a diffusive yet humed essay.

Believe me, Sir, sincerely yours
(late Edr Hall Amn, Mrs J. Nicholson Thorn 2

[5]

P.S.

This is not long enough without a postscript. I believe you are the inventor of the "letter-type" machine I have often thought therein if its "machinery" could be fixed so as to have the letter-hammers strike into a soft substance capable of hardening, a matrix to cast from could be secured, which would make the letter-type machine as much of a boon to "long-hand" as the sewing machine was to the seamstress. A few common double-letter keys as there would be useful if ~~the~~ it did not cause too much complication

A.

Com^r

[C]

Special Articulations.

The three vowels not specified in the scale table are special because limited to a few articulations. They are short ŏŏ as in pull, could, woman, A as in alm, alf, alve, and Ah as in are, pa. The vowel ŏŏ is confined to about two dozen very common words and a few terminals as ful whose frequency gives false ideas of its articulation importance. ~~A occurs chiefly ending~~ The chief articulations of ŏŏ are ŏŏd as in wood, should, ŏŏl as in pull, full wool, ŏŏk as in took, ŏŏs in puss, ŏŏsh in push. Continuant pŏŏ as in put, pull &c, bŏŏ as in bush butcher, tŏŏ as in took, hŏŏ as in hood, wŏŏ as in would, fŏŏ as in full.

A occurs ~~chiefly ending~~, only in the articulations with M.F.V as alm, alf, alve as in palm, half, halve except in colloquialisms as shant, in a few common words as aunt.

Ah chiefly articulates with Re as in ar-my p-ar, f-ar &c. It is also a final continuant chiefly in titles as pa, ma, Omaha.

The short a in at and ask some say to be different. Perhaps so but children and the writer cannot recognize the fact except the a in ask is made short o osk which is another thing.

The only other important vowel modification not specialized is that of medial au as in loss, cross, God, gone, dog, long, a very different sound from short o as in on, got, gong. It is nearly long au, and chiefly occurs before St, and Ng.

[7] The you sound usually called a vowel is an

articulation belonging to the oo ~~column~~ part of the Y Scale. Its vowel recognition comes from its peculiar single letter recognition and its compoundability after P, B, K, F, V, M, H with which it forms, ~~letter~~ at r, l or w does with consonants into a compound thus py, (pew) by, (bu-(ieu), ky, (cu-re) &c. It only articulates compounded with the oo vowel. Except the imperfect yoo compound in some terminals as ture, dure, after consonants other than the seven specified you is usually the initial continuant of a syllable as in vol-ume (vol-yoom), sinew (sin-yoo).

A full articulation table of common and special vowel articulations of each Consonant could be forwarded as these and many other facts are preparing for publication in an Orthographic Work. Only I seek to generalize and write in the absence of my papers in Troy which I daily expect; to begin a professional career here in Gotham.

Articulation Table

[8]

[ENCLOSURE]

3

Consonant Scales.

		Short Vowels					Long Vowels							
		1	2	3	4	5	1	2	3	4	5	6	7	8
No. of Scale	Sound	a	e	i	o	u	ai	ee	au	o	oo	i	oi	ou
1	T Continuous	at	et	it	ot	ut	ate	eat	aught	oat	oot	ite	oit	out
		la	le	li	lo	lu	tai	lea	tau	toe	too	lee	loy	tow
2	D	ad	ed	id	od	ud	aid	eed	aud	ode	ood	ide	oid	oud
		da	[illegible]	[illegible]	do	du	day	dee	dau	doa	doo	dee	doi	dow
3	K	ack	eck	ick	ock	uck	ake	eek	awk	oak	ook	ike	oik	ouk
		ca	ke	ki	co	cu	kai	kee	caw	coa	coo	ki	coy	cow
4	G	ag	eg	ig	og	ug	ague	eague	eaug	ogue				
		ga	ge-t	gui	go	gu	gai	gee(ee)	gau	go	goo	gui	goi	gow
5	P	ap	ep	ip	op	up	ape	eep	a	ope	oop	ipe	oip	oup
		pa	pe	pi	po	pu	pai	pea	paw	poe	poo	pie	poi	pow
6	B	ab	eb	ib	ob	ub	abe	eeb	aub	obe	oob	ibe	[illegible]	
		ba	be	bi	bo	bu	bai	bee	bau	bo-	boo	by	boy	bow
7	Ch	alch	elch	ilch	otch	utch		each		oach	ouch			ouch
		cha	che	chi	cho	chu	chai	chea	chaw	cho	chew	chi	choi	chow
8	J	adge	edge	idge	odge	udge	age	eige		oge	uge			ouge
		ja	ge	gi	jo	ju	jai	gea	jaw	jo	jew	gi	joy	jow
9	N	an	en	in	on	un	ain	een	awn	own	oon	ine	oin	oun
		na	ne	ni	no	nu	nai	nee	gnaw	no	new	nigh	noy	now
10	Ng	ang		ing	ong	ung			ong					
	Nk	ank		ink	onk	unk								
11	M	am	em	im	om	um	aim	eem		ome	oom	ime	oim	oum
		ma	me	mi	mo	mu	mai	mea	maw	mo-w	moo	my	moi	mow
12	H	ha	he	hi	ho	hu	hay	hee	haw	ho	who	high	hoi	how

[ENCLOSURE]

Consonant Scales

		Short vowels					Long vowels							
		1	2	3	4	5	1	2	3	4	5	6	7	8
Trial Scale	Sound	a	e	i	o	u	ai	ee	au	O	oo	I	oi	ou
13	th (in	oth	eth	ith	oth	uth	athe	ethe	auth	oath	ooth	ithe		outh
Consonant		tha-n	the-n	thi-n	tho-n	thu-n	tha-n	then	thau	thoa	thew	thyt		thou-ten
14	th						b-athe	ethe		oathe	oothe			
		that	the-n	thi-s		thu-s	they	thee		thoph		thy		thm
15	s	aso	eso	iso	oso	uso	ace	ece	auce	oce	uice	ice	oice	ouse
		sa	se	si	so	su	sai	see	saw	so	sue	syh	soi	sou
16	z	aso	ezo	izo	ozo	uzo	aice	eace	awes	oves	ooze	ize	oys	ouse
		za	ze	zi	zo	zu	zai	zea		zo	zoo	zi		zou
17	f	aff	ef	if	off	uf	afe	ef	auf	ofh	oof	ife	oif	ouf
		fa	fe	fi	fo	fu	fhe	fee	faw	foe	foo	fie	foi	fou
18	v	ava	eva	ivi	ovo	uvo	ave	eave	auve	ove	oove	ive		
		va	ve	vi	vo	vu	vai	vee	vau	vo	voo	vie	voi	vou
19	sh	ash	esh	ish	osh	ush								
		sha	she	shi	sho	shu	shai	she	shaw	shoe	shoe	shy	sh	shou
						gies								
21	l	al	el	il	ol	ul	ale	ul	all	ole	ool	ile	oil	oul
		la	li	li	lo	lu	lay	lee	law	loa	loo	lie	loy	lou
22	R	ar	er	ir	or	ur	air	ear	&	ore	oor	ire	our	our
		ra	re	ri	ro	ru	rai	ree	raw	ro	rue	rye	roi	rou
22	w	wa-y	we	wi	wo	wu	way	wee	wau	woe	woo	wy		wou
23	Wh	wha-ch	whe	whi	whoph		whey	whee				why		
	y	ya	ye-s	yi	yo	you	yea	ye	yaw	yo	you			yow

[ENCLOSURE]

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Consonant Compounds.

Continuants		Ending compounds						Notes on Compounding.
Tr	sf	Ls	nts	skt	lbd	rd	rf	~~ch~~ n, l, s, ~~g~~, ~~w~~, y are the
lw	sl	Dz	nd	sp	lk	rdz	rfs	compounding elements of the
Dr	skw	Ks	ndz	sps	lkt	rk	rft	continuants, s being used
dw	spy	kt	nsk	spt	lch	rks	rv	initial and the others final
Kl	sh	kts	nskt	Sd	lchd	rkt	rz	This borne in mind makes it
kr	spr	kst	ny	Zm	ly	rg	rvd	easy to think out the continuant
kw	spl	kts	nyd	gmz	lgd	rgz	rsh	compound of a simple consonant
ky	Fr	kstl	nsl	zmd	lkt	rp	rl	as pr, pl, py (kw, ks), sfs, sfr, sfl
gr	fl	ktts	nts	Ts	ltts	rps	rly	spy (sh-wing) or kr, sk, tw, ~~sts~~
gl	fy	fz	nk	ft	lf	rpt		Sapt from the future power of s, z.
gw	Vy	gd	nks	fts	lfs	rt		Most ending consonants rebuilt
Pr	thr	Ps	nkt	Vz	lfth	rty		from the grammatic terminals
pl	Zy	pt	ngz	Vd	lfths	rtd		s, ed which as — then consonants
py		pts	ngd	Sht	lv	rch		form only with thin ones, dence
Bl		pst	Nk	Ls	lvz	rcht		with dence — represents then d, J,
br		ptk	mps	lst	lvd	rj		after thin consonants like J, P, Cl
by		ptks	mst	ly	lch	rjd		K &c and Z, D after dence sounds
My		Rz	mt	Sl	lm	rn		like D, B, G, J &c. The unmated
Hy		kd	mts	lts	lmz	rnz		definite ~~[illegible]~~ consonants m, n, l, r
Shr		Cht	md	ld	Rs	rnd		had the character of both dence
thw		Jd	Ns	lty	.nst	rnt		and thin consonants hence take
st		ks	Dhy	lk	nsts	rm		s and z, l and d after them as in
sk		nst	St	lks	ry	rmz		ants, ands. Only st, sp, sk are
sp		nz	sts	lpt	rkd	rmd		definite compound, forming ending T continuant
sn		nsd	sk	lt	rt	rmsh		Full stand in table of Illustration.
sm		kt	sks	lkz	rts	r		forms if desired. Bounds only represent(s)
								abbreviation

Boston Hotel Berkeley May 3. 1878

My dear Mr. Edison,

I am much obliged for the enclosure of Mr. Frazers paper and for your letter of the 1st inst. I have good reason to appreciate the disadvantages of working with the phonograph which I have and should be glad to study results from a better machine. My professional work will keep me at present in Boston otherwise I should be very glad to accept your offer and have a few days in Menlo-Park, and in addition to my usual work I am now considering the plans for a new quarterly journal to be devoted exclusively to Acoustics and Otology; the field of Acoustics has broadened so much in the few past years that a special journal of this sort can be made to do good service.

Although I cannot easily get away again until Summer I am still find time for experiment at home and should be very glad to join hands with you by carrying out scientific investigations on sound with the phonograph, placing any results which I might

[1]

get at your disposal in the hope that you might be able to turn them to practical account, which sort of work is not in my line.

If you could send me one of the perfected phonographs I can easily arrange with the parties having a pecuniary interest in your invention one of whom I saw yesterday and who expressed the wish that I might have one for experiment.

The results which you have gained in volume and clearness of articulation are certainly most satisfactory but I am not sure but that they can be further augmented, and getting rid of the sounding funnel at least is an advantage.

The experiments with the Bell telephone made for the British Society of Telegraph Engineers led to some interesting investigations upon the manner and limit of vibration of the ferro-type disks and though at first sight it might not be expected I found that the ferro-type plate transmits with almost astonishing accuracy the more delicate overtones which give the quality of the human voice. In addition however the plate of course gives prominence to certain overtones to which it especially responds, and these reproduced impair the delicate qualifying tones. – a good rough illustration of this is got by listening through a tube having a ferro-type disk over the end nearest the speaker – In the phonograph all of these overtones are embossed upon the tin foil – now if after speaking into the phonograph with the metal disk, we can substitute a disk or membrane which vibrating on the principle of the drum membrane of the human ear will not repeat the "metallic" overtones but will give the more delicate overtones we should expect to get a more accurate reproduction of the human voice in its finer shades of quality.

One point is worth considering in this connection - in following the mechanism of the human drum membrane it is necessary to remember, as you have indicated in your letter, that this structure has to fulfil not only the office of transmission of sound waves of a certain character but also the office of protecting the deeper seated and more delicate parts of the ear from undue violence.
The mistake which physicists usually make in this direction is in endeavouring to reproduce the mechanism of the drum membrane as a whole instead of imitating the particular function which they wish to reproduce. For the purpose which you have in view it is necessary to reproduce only one principle, namely, its power of responding equally not only to the more decided but also to the slightest portion of the impulses of complex sound waves. It is just here that the
[4] plane surfaced, comparatively inelastic metal disk is at fault.
If from the tracings already made on the tin foil by a metal disk, the vibration can be communicated to the centre of a membrane having a double curve, the more delicate overtones will be more clearly reproduced in the air outside of such a membrane and the sharper "metallic" overtones cut off in proportion.

This effect I have endeavored to reproduce, with some success and I hope greater in the future - as follows. After making a tracing with the metal disk, this was removed and a disk of stout paper, held in place by strips of sand paper at its circumference and changed in a steel ring was substituted. In order to make connection with the embossing point a piece of light pine wood with a rubber cushion at each end was
[5]

placed between the centre of the paper disk and the steel spring. (Fig 1.) the result being two fold.
1. the paper was stretched into a double curve and its tension repeated by the elasticity of the steel spring.
2. the effect of the counterbalance was reproduced by the elasticity of the paper augmented by the double curve from centre to periphery on either side (Fig 2)

A piece of drum head soaked and tightly stretched may be used instead of paper and the curve increased by central pressure during the drying process.

So far as I have gone the results with these forms of transmitting disk were fairly good, giving a better quality of voice and rendering it with a volume which makes the funnel entirely superfluous, and I abandoned

[6]

effect, (after embossing with the metal disk) by using a membrane of the principle, two thirds or more larger than the metal disk to get results which could be made available for the phonographs as a public speaker.

The exact amount of tension which is lost: the character and length of the rod (a) and the strength of the spring (b) are points which are important and which I have not yet had time to take up.
There is a certain degree of tension in the paper and membrane beyond which the good effects begin to diminish.

In regard to covering the cylinder with rubber the reason for so doing was this, I found that the air under the tin foil in the groove on the cylinder acted as a reservoir to the always scratching nose of the

[7]

embossing point, rubber is an

of allent "deadener" and seems to answer the purpose here.

In regard to the vowel sounds a pretty definite and marked ~~difference~~ difference in speed of rotation is necessary to produce a clear change in the vowels, and in regard to consonants, Prof. Cross and I can confirm your observation, contrary to that of Prof. Jenkin. On examining the tracings of consonant sounds which I left at your laboratory you will see the marked difference in the sound waves in different parts of the consonant which would preclude the possibility of reproducing them backwards, this can also be shown with an accurate phonograph making tracings on smoked paper on the cylinder, or on smoked glass. If you can repeat the experiment with the sounding disk described I shall be pleased to know your results.

Very truly yours

Clarence J. Blake

[8]

T. A. Edison Esqr.

Minneapolis. Minn
May. 6. 1878

Thos. A. Edison. Esq.

Sir.

I have made three improvements, as yet theoretical, i.e., untested by experiment, on your phonograph, and one on the telephone. The first, is designed to intensify the upper notes repeated on the phonograph; the second, to intensify all the notes, beyond their original strength both without the use of organ pipes. The third, extends of practical, the use of the phonograph beyond its absurd sphere of application. The one on the telephone is designed to enable it to repeat all notes or sounds with equal distinct

near as the original, ie, no difference between high and low water. These improvements, if found successful, should be of value. Therefore I wish to inquire what facilities in the way of testing you can afford me, in the direction of instructions rent of instruments for a short time, so to be returned in good order. Also can you afford me any information relative to the probable value of such improvements, if proved successful?

Yours respectfully,
Wm Waler Jr.

P. S. What is your royalty charge for privilege of construction of instrument, and your price for cheapest form already made.

[ATTACHMENT]

Know all men by these presents.
That Wm. Wale Jr. resident of the City of Minneapolis, County of Hennepin, State of Minnesota; and Thomas A. Va. Edison, resident of Menlo Park, near Newark, State of New Jersey; do respectively covenant and agree.
That upon the said Wm. Wale giving to the said Thos. A. Edison a full and complete description of the following improvements on the phonograph and telephone, to wit;
First, an improved register medium for the phonograph, by the use of which it is proposed to preserve the quality of high or forcible tones registered thereon; which tones are at present deficient in quality or timbre.
Second, an improvement or accessory to the phonograph, whereby the increase in volume of all tones is to be effected, in a degree equal to or beyond the original volume, without the use of organ pipes.
Third, an improvement designed to effect the register of sounds whose vibrations are in plane lateral to the plane of register medium of the phonograph.
Fourth, an improvement designed to secure the equal transmission of the quality of either soft or forcible notes received and transmitted by the telephone; also applicable to the phonograph.
Of all which improvements the said Wm. Wale

[ATTACHMENT]

believes himself the true and original inventor in respect to their application as stated to the phonograph and telephone.

That the said Thomas A. Edison is to test the practical working of the same, and if found valuable, and applied by him to improve the working of the instruments herein before named, he is to apply for a patent thereon at his own proper cost and expense, upon a satisfactory agreement between himself and the said Wm. Wales, reflecting the term of the value of said improvements to the said Thos. A. Edison.

Otherwise the present instrument is to stand in bar of the use of said improvements by the said Edison or his assigns.

Witness our hands and seals.

Wm. Wales Jr., this 21st day of May 1878.

Jefferson Medical College Hospital,

Sansom Street, above Tenth.

Philadelphia, May 8th 1878

Prof. T. A. Edison

Menlo Park N.J.

Dear Sir;

Allow me to thank you for your kind attention to my letter in regard to my brother's ideas of recording words. Your assistant is quite right in regards to its application.

Hoping you will forgive me for trespassing on your valuable time I remain

Most Respectfully

Saml E. Jones

Austin Texas May 9/78

T. A. Edson Esq
Newark N.J.
Dear Sir

about the time you produced your Phonograph I had the same thing. complete although in different form. your Phonograph embodied the form which was better calculated to subserve my ends than the one I had being more simple — I at once set about applying its principle to Telegraphy and some six weeks ago obtained what I consider complete success I constructed two Phonographs worked by clock work to run at half or full speed I run my transmitter at full speed took my voice indentations on it then turned it back placing a very delicate circuit breaker in contact with it that dropped into the impressions closing the circuit the machine was run at half speed first giving a signal to the other station to start his Phonograph at

half speed the receiving instrument had a
style traversing the groove the same as a morse
register and ~~also~~ operated by an electro magnet
the impression was faithfully recorded the cylinder
was now turned back and set in full motion
the result being a complete reproduction of
voice in very distinct tones I tried it on two
different occasions it worked perfectly over
two hundred and fifty miles of line on one
occasion and nearly four hundred on an
other this I had to do clandestinely having been
refused access to the W.U. office by cutting
wires, my assistant was a one horse lawyer
and worked upon my generosity until I advanced
him $80. to go to Washu and procure patents
at once the last I heard of him he was
up in the Indian nation on a first class
drunk. this principle admits of the phonograph
being used either with the duplex or quad and
dispenses entirely with the inductive effect I
used to work with you occasionally when
in Cinti and had rather you would have the benefit
of the invention than any one else I am
now bankrupt and out of luck working for
the modest sum of 1.50 per day in a foundry
doing machine work I should like to see you
put the thing in practical operation at once
and if it would be of any assistance I
can send you complete drafts of the aparatus
it is not necessary to have the cylinders revolve
chronographically as an approximate speed ~~xx~~
produces satisfactory results the point for
closing the ckt when drapping into the indentation
I had so arranged as to throw the platinum points
four times the distance it traversed this was
done by reducing a watch spring and arranging
it thus

if you need any assignment
or other papers they are yours
gratuiously as its out of my present
or prospective range to go any further with
it

Resp'ty Yours
Geo: A. Fitch
Arlington Iron Works
Austin Texas

Stevens Institute of Technology,

HOBOKEN, NEW JERSEY.

May 9th 1878

My dear Mr Edison,

I have been so busy getting my book on Sound through the press that I have had not time for research since I last wrote to you. My little book I hope to see out in the world in a few weeks and will then send you a copy with Author's regards.

I wish to make several more examinations into the profile of indentations in the Phonograph. Professor Henry Tarkin of Edinburgh & Mr Ellis of England are, I think, wrong in their ideas about the vowel sounds &c of your phonograph. Let me have the two points for the phonograph now is worn out. You may remember you said that you would send me two properly shaped.

I suppose you saw my article on the Phons. in "Nature". It has also appeared in France ("Journal de Physique") and in Germany.

Yours truly

Alfred M. Mayer

(1

Formerly of the Firm of
HOBBINS, CLARK & BIBBLE.

J. P. CLARK,
MANUFACTURER AND IMPORTERS' AGENT
FOR THE SALE OF
WATCHES, DIAMONDS, JEWELRY, ETC.,
929 CHESTNUT STREET, 2d Floor.

Philadelphia, May 12th 1878

Friend Edison

I thought after I saw you on Friday, that if it was really necessary, for you to have a point, for the Phonograph "harder" than Steel, that I could readily have made for you (but not by a Lapidary) from the "Ruby pin" for a watch a better point, than you can possibly get by having them cut from the rough. I do not of course know, without some explanation why you want so long a point as I have seen on the Spring, which I only casually glanced at. I would have spoken to your Mr. B. when at Menlo Park but, as

(2

he did not come in to the Laboratory, until I was about starting for the train, and did not know me, I said nothing special about it. The "pins" I speak of could be made about this size and fastened to the springs, by screws, which would not draw the temper of your spring at all. Something like this "section" or, to make it more distinct . If you will send me a spring, I will fit one up for you. I don't believe a lapidary, would be able to do it as economically, or anything like as true, as the pins, (of fine quality) come all ready, either round, oval, flat face, or square, and would of course save the slitting of the stone, beside being smaller work than is usually done by the

(3

"Jewelers" Lapidary, and in an entirely different manner, as it is altogether lathe work and consequently positively true.

Regarding my own affairs, please believe me, when I say, that I have myself worked, as you told me you had. And just now, after spending the best years of my life, in putting other people in a position to reap the benefit of my own experience, I am on the verge of ruin for the want of an immediate help, pecuniarily to tide me over. I am today in the best position I ever was if I can only raise some $1500 at once which I will be able to pay, entirely independent of my business, in October. Will you allow me to make a

Formerly of the Firm of
BOSSING, CLARK & BIDDLE.

J. P. CLARK,
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929 CHESTNUT STREET, 2d Floor.

Philadelphia, ... 187

full ~~statement~~ of how I am ~~situated~~, and why I am in such a condition? For the sake of my Wife & Child, I would do anything honorable, and I know that if anyone will help me now, it will not only be my salvation, but a safe investment. It may seem strange that I should be in so destitute and desperate a plight, but if I could explain to you, you would I believe help me out. I am

Most respectfully yours
J. P. Clark

Boston Hotel Berkeley
May 12. 1878

My dear Mr. Edison,

Yours of May 7th came duly to hand. I am quite sure from my own experience that the diaphragm idea may be made serviceable. Pray do not abandon it if it does not work successfully the first time as I am sure that the principle is correct. The curved membrane responds to a large number of slight overtones on account of its varying tension, the greatest tension being in the centre which receives the impulse. Stretched bladder and drum head wetted and pressed into form answer well both for recording and sounding disc. and return the record of the metal phono-disc louder but softer.

I hope to send you an ear preparation next week.

Very truly Yours
Clarence J. Blake

P.S. The thickness and quality of the paper or membrane used makes considerable difference of course. in the loudness relevance of the sound re-

produced.

May 14th 1878

119 Savin Hill Ave. Dorchester Mass.

Thomas A. Edison Esq.
Menlo Park N.J.

Dear Sir

Your letter of April 22nd is received, in reply to mine of 17th for which accept my thanks. I understand from the Boston papers that you intend visiting that city before your exhibition of the Phonograph closes, will you let me know when you come? so that I may see you in relation to my letter of April 17th. I have visited your wonderfull invention and although I have not had a chance to ask the operators questions in regard to it, still a number of trivial mechanical difficulties came under my observation, which I would like to show you remedies, and if you wish and can spare your valuable time I will send you some of my ideas. They relate chiefly, 1st to increasing the sound, 2nd improving the quality of utterance 3rd substituting another material for the tin foil, 4th also in duplicating the tin foil more cheaply than in stereotyping. In the machine as it is used by your lecturer without scarcely altering its simplicity, remedying the noise

of the chizel as it moves over the foil
The noise over the lap, The
sticking of the edges together. Running
of the machine back. The repetition
of former spoken sentences although this
latter is quite amusing sometimes.
Also ideas in relation to your
new form of machine, which the lecturer
or operator tell the public you are now at
work on.

Yours Most Respectfully
Isaac H. Davis

Boston
Hotel Brotsky
May 17. 1878

Dear Mr. Edison,

I hope that you are making a practical success on the principle which I indicated, as I am quite sure that you will be able not only to have a more sensitive diaphragm which will record from a greater distance but one which will return a greater proportionate volume and better quality of sound.

Since last writing you I have been able to test the effects of more sensitive diaphragms with good results and should be very glad, when you have time to spare to know what you have done in this direction. I see by the papers (not always reliable) that you have succeeded in improving your own hearing. for which accept my sincere congratulations

Very truly Yours
Clarence J Blake

89 Savin Hill Ave. Dorchester Mass 18th May

Thomas A Edison Esq.
Menlo Park N.J.

Dear Sir.

Yours of 16th inst. received. In regard to a "substitute for tin foil" mentioned in your letter, I will give you my ideas as they consist of now; but tomorrow they may be entirely changed, as this matter has been but the occasional thought of a few days my attention since visiting the Exhibition having been more directed to the quality and intensity of the voice. Having no chance to ask question I was obliged to depend solely on my perception, I came to these conclusions since I have seen the instrument in regard to the tinfoil or I will call it the "record plate", (as the operator said your new machine was a disk)

1st If 40,000 words are to be placed on the disk of 10 in. in diameter, these indentations are so minute and small, that a perfect matrix cannot be obtained by the usual method

on account of the presence of air and oil in the molecules.

2nd That even if a perfect matrix was obtained plumbago could not be used in electrotypy

3rd The sheet or record must bear careless handling both in the mail and mass hands and must not alter its shape

4th It must be easily set on the machine so that an ordinary child could do it, also removed

5th It must be light in weight to save cost in mail correspondence

6th It must be durable enough to repeat a dozen times for a letter and for book one or two hundred times

7th For mail uses (correspondence) it should be cheap

8th The material should be plastic and elastic

9 Stiff enough to vibrate the diaphram with out injury to its surface

10 A very smooth surface is essential

These ideas that I advance in this letter are somewhat crude as I have to depend on a good memory I possess and also lack of time for examination of works from which the information could be obtained, Also some of my ideas may be in entire opposition to your own and might make great changes in the machine.

I will first consider correspondence or Letter Writing, —

Instead of growing the plate or disk of the machine I make it perfectly flat with two bevelled pins place in the edge of the plate also a flat spring pin, these pins being equal distances from each other

These pins can be easily removed and placed at the or around (at equal distances) the center of the plate.

The record disk consist of a sheet (round) of Paper Mache or Vulcanized Fibre the scroll or groove of which is stamped or pressed into its face, pasted over the top of the groove is a thin disk of tinfoil or lead foil (Note) Lead foil or tin foil can be prepared with mercury and bismuth which will make it softer than in its natural state

Vulcanized fibre is paper prepared with chloride of zinc with the addition of

oxide of zinc, The paper can be prepared or it can be formed from the pulp. With the addition of some gum starch &c it can be made very hard and firm, tough, or soft and pliable. It is impervious to water and will resist most of the acids and alkalies. It is the generall appearance of horn as a smooth surface and is rolled or pressed into the form spoken of.

It is cheap expands or contracts but very little. This "record disk" is stamped with its scroll grooves, the tin foil stuck on and is sold for letter writing, they can be made from the size of a half dollar to the size of the disk according to the size of the letter. (1/8) One eight of an inch would be thick enough. As there is but one way for them to go on the plate, no danger of misplacement - as the pin notches are pressed the same time the grooves are.

The operator slips it on the plate of the phonograph, set the clock work going and talks his words to the machine.

When done slips it off the Phonograph and places it in an envelope and sends it to his correspondent, who receives it, and as the disk is stiff and firm can carefully place it on his Phonograph and hear what is said. When the "record disk" is to be sent a long distance or to be handled roughly, the operator thrusticks on the thin tin foil, minutely with shellac which of course fill the grooves which hardens and forms a bed for the tin foil, after the record is made

Plan 2nd Using a very thin sheet of the Vulcanized fibre which is afterwards hardened, & this sheet pasted over the grooves of the Tablet or "record disk"

Plan 3rd Filling the grooves with a gum or cement, then the tablet or record disk given a chemical bath to harden it

after the record is made –

For the purpose of books &c I would print them in a press especially constructed for the purpose. After the book was dictated to the Phonograph, and the "record tablet or disk" had received its indentations, I would electrotype its surface with nickle or copper I would then back the nickle or copper surface with mettal and then burn or remove the "record tablet or disk" from its face. I now have a cylinder the cover of which forms the die just spoken of, this cylinder is connected with an air exhaust receiver, and also an air compresser.

Mode of opperation, A thin sheet of "Celloid" or "Vulcanized Fibre" "Gutta Percha" "Paper Macha" or any suitable material is laid in the cylinder, This sheet before its introduction has had its surface polished, Now the air is exhausted from the cylinder to as perfect a vacuum attainable. The die or former being in the upper part is in the most rarefied space. The clamp raises and forces the edges of the material against the outside edge of the die or former, Hot compressed air is now admitted, which first softens and then forces the Celloid against the die, With Gutta Percha the same with Vulcanized Fibre or Paper Macha it forces it against the ~~disk~~ die and then hardens. Could not these substances be coated with nickle? The heat of the above substances is easily regulated.

Very thin copper could also be forced against the die by the same process which could be afterwards coated with steel ~~as is~~ (very thin) as is now done in engraving. It forms a very hard surface. I think by the study of various cements, alloys of mettals, rubber substitutes &c a very supperior article could be obtained. In writing the above all that I could depend on was what I had seen in years gone bye of these substances. Tanite, Union Stone

Mineanite, Diatite, Celloid, Gutta Percha &c.

I see no obstacle in cutting an enlarged iron plate by the diamond simply following the indentations of the recording tablet or such to be used by Lecturers &c.

If any of these ideas strike you favorably I will make them clearer if wished for. These Record Diskes or Tablets should be sold cheap depending of course on their use. One or more diaphrams might be used on one machine to assist the quality and intensity of tone also for varying voices in singing, different musical instrument in playing, and to make a copy of a letter when corresponding, in letter writing.

Yours Most Respectfully

Isaac H. Davis

P.S. would not oiling the surface of the "record tablet" assist in the reproduction of words

H. B. BIGELOW. E. F. MERSICK. FREDERIC IVES.

OFFICE OF

The New Haven Sanitary Pump Company,

MANUFACTURERS OF

Highly Perfected Excavating Apparatus for Removing and Transporting the contents of Vaults, Sinks, Cesspools, Catch-Basins, &c.,

IN A PERFECTLY ODORLESS MANNER.

New Haven, Conn., 21 May 1878

Thomas A. Edison
Menlo Park N. J.

Dear Sir,

Have you ever tried a glass diaphragm in the Phonograph
Would it not be better than iron?

I hope you will forgive me for making so many suggestions but I take a deep interest in your great invention

Yours truly

A. W. Johnson.

Boston Hotel Berkeley
May 22nd 1878

Dear Mr. Edison.

Yours of yesterday came duly to hand. I am very glad to know that you are getting on with the diaphragm suggested. I have used diaphragms curved in both directions, toward the cylinder and from it with equally good results, and have had a mold made to press paper and drum head so into the desired form. and am positive that the improvement in this part of the phonograph lies in this direction, imitating the principle of the vibration of the human drum membrane. I got some very good records with these diaphragms at a distance. I have noticed the squeak with loud talking which you mention, The pneumatic pressure of a loud voice causes a mechanical vibration of the diaphragm itself which is recorded in addition to the quality overtones of the voice. You can test this on the clockwork machine by comparing

tracings at the same rate of speed with a natural voice and with a loud voice and examining the tracings. If you have got any improvement on the new diaphragm I wish that you could send me one with the clock work machine to compare with mine.

Here is an experiment to be tried with the clock work machine, - viz - the recording of vibrations inaudible to the human ear and reproducing them audibly by lowering the rate of revolution - as for instance, connecting the frogs leg galvanometer with the disk of the Phonograph and making a record. In fact the experiments in Acoustics which the clock work machine will render possible are constantly suggesting themselves.

By the way - my experiments in using the preparation of the human ear as a telephone, which I regard merely as a sort of scientific curiosity, have turned out very well. with a preparation of the drum of the human ear, a disk of ferro-type plate 7 millimeters in diameter, a magnet about an inch long and a fine coil (44 Ohms resistance) I have been able to talk easily between my house and office, on an overhead line over 600 ft. long.

Shall be very glad to hear the results with the clock work machine. Have you tried the rubber on the cylinder?

Very truly Yours
Clarence J Blake.

J. E. Suitterlin, Director.
Robert M. Zug, Ass't Director.

The American Vocal Institute.
203 Waverley Place.

New York, May 23 1878

My Dear Sir -

As I often come in contact with the Phonograph a thought has so often come to my mind in regard to the vibrating diaphragm; Science shows us that primitive sweetness of sounds, with purity & clearness, are best produced by silver and glass over all metals, possessing the clear, pure vibrating qualities, leaving the vibrations to stand out distinct, without being choked and encumbered with confusing ingredients, as the diaphragm that you now use seems to me to be - indeed the illustration of it must be simple, by contrasting the ring of the several metals on a table or hard wood surface, the Phonograph is naturally

in this element of purity -

Feeling myself upon "How are you" acquaintance with you I trust you will pardon this liberty - I do not doubt but that you have tried silver & got I question whether you are done experimenting on this very important part of the machine; silver would certainly give a very different & more pleasing timbre to the vibrations or tone -

Wishing you continued success & prosperity I remain

Very Respectfully

Your Obd Servt

J E Smitterlin

Thos A. Edison Esq
Menlo Park N.J.

Somerville Mass

June 1 1878

Mr Edison

Dear Sir

A recent article in Scribner's Magazine on the Phonograph set me thinking and as a result I would like to make the following inquiry.

If the stylus were to oberate parallel with and the drawn foil at right angles to the diaphragm instead of the direct opposite as at present, thus recording spoken language by water lines (~~[illegible]~~) instead of punctures (.....) might not a greater accuracy of reproduction of tone be obtained? I don't know

that my idea is at all practicable and I have neither time or talent for experimenting, and write you hoping if your time permits you will favor me with a few lines as to the practicability of the idea.

If it is of any value you are welcome to me the assertion

Very respectfully
H. O. Johnson

P.S. enclosed please find stamped envelope

Somerville Nov June 1 78
H O Johnson
Ans'd June 3rd 78

30

Chicago Ills. June 2nd 78

Mr. Thomas Edison

Dear Sir: May I introduce myself to your favorable notice as one who would be pleased to meet you, to suggest and perhaps aid you in perfecting a new use of your Phonograph entirely medical in its nature? I take it for granted you would wish to generously cooperate with anyone who would extend the usefulness of your valuable discovery — I have just completed an instrument I think I shall

Chicago June 2d
Dr Chas Denison
Ans'd June 6 78

call the Respirograph which I shall be pleased to show you, It is run by an electric engine which in a combination instrument might possibly run the phonographic part.

I am on my way from my home in Denver Colorado to attend the American Medical Association at Buffalo June 4th to 8th. I hope to be in New York Saturday morning next & if you will drop me a line when thereafter I may come to your place of experimenting - with directions how to reach you - I shall be pleased to find you out.

If I was to refer to any one I think I should chose Prest. F.S. Winston of the Mutual Life Ins. Co. of N.Y. (to whose care 146 Broadway please send your note,), or to my brother in law Prest. E. M. Gallaudet of the National Deaf-Mute College Washington D.C.

Trusting it will please you to send me a favorable reply

I am yours
with great respect,
Charles Denison M.D.

P.S. You will find me a young man of about your own age & full of a kindred liking to get up something new, though with me of course the desire is coupled with some professional utility.

OFFICE OF THE

UTICA MORNING HERALD AND GAZETTE,

Utica, June 6, 1878.

Thomas A. Edison,
Dear Sir:

You have invented so many wonders, that any suggestion to you may seem impertinent. But you are so near an invention which may save vast labor, that I venture to propose it. Can you not connect the phonograph or telephone with a typewriter, so that the voice may produce legible writing? This will enable the editor to talk his editorials into copy that may pop into the hands of the printers.

The idea is practicable. Is it not worth your while to produce the machine?

Yours Very Respectfully,
Ellis H. Roberts.

ROCHDALE, MASS., JUNE 10., 1878.

MR. T. A. EDISON,

DEAR SIR:-

YOU WILL EXCUSE ME FOR INTRUDING ON AN INVENTOR OF YOUR RENOWN ONE OR TWO SUGGESTIONS, WHICH MAY BE OF NO USE WHATEVER. HAD I THE MEANS OF EXPERIMENTING WHICH YOU HAVE, I WOULD NOT TROUBLE YOU WITH THE CRUDE IDEAS, TILL I HAD PROVED WHETHER THEY ARE OF ANY VALUE WHATEVER.

HOWEVER, IT WILL NOT TAKE VERY MUCH OF YOUR TIME TO READ MY COMMUNICATION, & YOU WILL BE VERY LIKELY TO KNOW AT ONCE , FROM YOUR OWN PAST EXPERIMENTS , WHETHER THEY ARE OF ANY VALUE.

FOR THE FIRST TIME LAST WEEK I HAD THE PRIVELEGE OF SEEING , IN BOSTON, THE ''PHONOGRAPH''; & WHILE NO ONE CAN BUT ADMIRE THE WONDERFUL INVENTION, AT THE SAME TIME I EXPERIENCED A DISAPPOINTMENT IN TWO RESPECTS.

FIRST, THE THING IS SO HARD OF HEARING THAT IT IS PLAIN AT ONCE THAT IN ORDER TO BE OF SERVICE IT MUST BE IMPROVED IN THAT RESPECT.

AND AGAIN, IT TALKS IN SO FEEBLE TONES THAT THE DESIRABLENESS OF GIVING IT A LOUDER TONGUE IMPRESSES ONE AT ONCE.

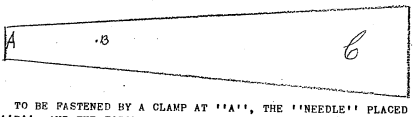
OF COURSE YOUR AIMING AT THIS, WHICH HAS IMPRESSED YOU AS FULLY AS IT CAN ANY ONE, IS LEADING YOUR MIND INTO CHANNELS WHICH WILL IN TIME BRING WHAT YOU SEEK. THE PHONOGRAPH, LIKE THE BEGINNINGS OF PHOTOGRAPHY, HAS IN IT THE GERM OF GRAND ACCOMPLISHMENT, WHICH YOUR INVENTIVE GENIUS WILL BRING TO FAR GREATER PERFECTION.

BUT TO THE IDEAS TO WHICH I HAVE REFERRED.

AMONG A NUMBER OF SUGGESTIONS WHICH HAVE OCCURRED TO MY MIND SINCE SEEING THE PHONOGRAPH, TWO ARE ESPECIALLY PROMINENT.

I. THE FIRST IS THIS:--- WHY MAY NOT A TONGUE, INSTEAD OF A DISK, BE EMPLOYED TO CONVEY THE VIBRATION ?

LIKE THIS:-



TO BE FASTENED BY A CLAMP AT ''A'', THE ''NEEDLE'' PLACED AT ''B'', AND THE FORCE OF THE VOICE EXERTED AT ''C''.

IT IS EVIDENT THAT, ON THE LEVER PRINCIPLE, A MUCH LIGHTER FORCE OF THE VOICE APPLIED AT ''C'' WOULD BE EFFECTUAL IN PRODUCING THE SAME RESULT THAT REQUIRES A VERY GREAT EXERTION IN THE MACHINE WHERE THE DISC IS USED.

ALSO, WHEN THE SOUND IS RE-PRODUCED, THE GREATER MOVEMENT OF THE ''TONGUE'' WOULD PRODUCE A LOUDER TONE THAN IN THE CASE OF THE DISK.

THE OBJECTION WHICH OCCURS TO THE MIND IS, THAT WITH THE TONGUE OTHER VIBRATIONS MAY COME IN, & SO INTERFERE WITH THE ARTICULATION AS TO INJURE, & PERHAPS DESTROY THAT ARTICULATION. AND THUS THE DESIGN OF THE INSTRUMENT BE ALTOGETHER LOST.

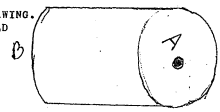
I THINK IT LIKELY THAT YOUR PAST EXPERIMENTS MAY HAVE ALREADY DETERMINED THAT POINT, & LED YOU TO DISCARD THAT ARRANGEMENT.

I DO NOT KNOW THAT THE PRINCIPLE WILL WORK AT ALL.

2. MY SECOND THOUGHT IS THIS:-

MAY NOT A DRUM BE EMPLOYED, IN THIS WAY ?

:EXCUSE THE ROUGH DRAWING. I HAVE A SON WHO WOULD DO IT WELL, WERE HE WITH ME.:



A SOLID METALIC DRUM, WITH THE HEAD ''A'' SOLID, & AN OPENING OF AN INCH, MORE OR LESS, IN ITS CENTER.

THE OTHER HEAD AT ''B'' TO CONSIST OF THE DISK, OR ''TYMPANUM'', WHICH CONVEYS THE SOUND, THE VIBRATIONS.

ON THE PRINCIPLE OF HYDRAULIC PRESSURE, EVERY INCH OF THE TYMPANUM WILL HAVE THE AMOUNT OF PRESSURE WHICH IS THROWN IN AT ''A''.

THEREFORE, A MUCH LARGER TYMPANUM CAN BE USED, & IT WOULD CONSEQUENTLY FEEL A MUCH MORE DELICATE TONE THAN A SMALL ONE SUCH AS YOU EMPLOY.

IN THIS CASE I AM NOT CLEAR IN REGARD TO RE-PRODUCING A STRONG TONE, THO' SEVERAL THOUGHTS OCCUR.

MY PRACTICAL STUDY OF VIBRATING BODIES IS LIMITED, & THEREFORE I MAY BE TROUBLING YOU WITH THAT WHICH HAS NO VALUE WHATEVER.

IN CASE A ''TONGUE'' WERE USED, MIGHT IT NOT BE MADE TO VIBRATE, FOR RE-PRODUCING, IN THE MOUTH OF A HOLLOW CYLINDER, OR HEMISPHERE, & THUS INCREASE THE SOUND ? (a mouth not unlike an - proper in your present arrangement of cylinder?)

YOU WILL EXCUSE THE INTRUSION OF THESE IDEAS; BUT THE THOUGHT THAT THEY MAY BE OF SOME USE LEADS ME TO SUGGEST THEM. EVEN

A MIND LESS INVENTIVE THAN YOUR OWN MIGHT SOMETIMES AFFORD SUGGESTIONS WHICH CAN BE WROUGHT INTO SHAPE, & PROVE OF VALUE.

I AM GREATLY INTERESTED IN THE INSTRUMENT. HAVE APPLIED FOR TERRITORY IN WHICH TO EXHIBIT IT; BUT FIND ALL TAKEN UP.

I AM, DEAR SIR, VERY TRULY YOURS,

[REV.] S. R. BAILEY.

I hesitate about sending it, knowing how little likely it is to be of any amount. But you will excuse it, I believe.

Sincerely & Respectfully,

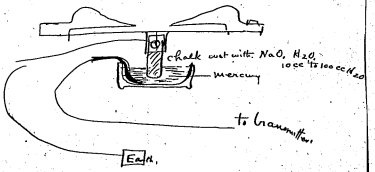
Yours, S. R. B.

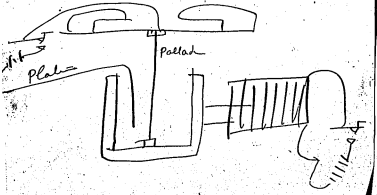
file, Phaus
Suggestion
Erasing Gilliland

CHARLES BATCHELOR COLLECTION

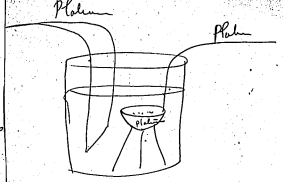
1879-1880

July 5 1879
T.A.E.





attraction of palladium when charged with Hydrogen.



dish Carbon Iridosmine

Dilute Sol NaO, 1

If platinum attacked use Carbon: Wohler states that Iridosmine readily dissolved this way also. Ruthenium; Vide Annal Scientific Dis 1870 p 196 –

Method making absolutely pure Iron – See same p 197.

THE EDISON ELECTRIC LIGHT CO.,
8 BROAD STREET.

NORTH GREEN, Pres.
R. M. GALLAWAY, V. Pres.
E. P. FARRIS, Treas.
C. GODDARD, Sec'y.

New York, Decem 24th 1879

Charles Batchelor Esq
Menlo Park

Dear Sir

I purchased thro' Drexel Morgan & Co $9.000 U.S Reg 4% at 103 1/8

$9.281.25

& enclose my cheque 718.75

$10.000

being proceeds sale of your 10 shares stock - I hold due bill of D M & Co for the bonds to be delivered when transfer books re-open -

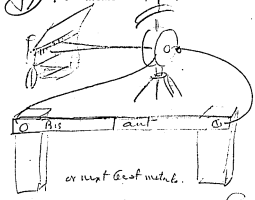
I telegraphed you for authority to sell 5 shares more at $2.000. but purchaser has not yet come to time - think I shall be able to get that for it Friday morning

Yours truly C. Goddard

T. A. EDISON.

Batch

Menlo Park, N. J., 187



Bend junction of thermo
+ see if deflection

T. A. EDISON, 10,00. 100

20.

50. Menlo Park, N. J., May 1880.

Entitled to a sum equal to the amount of dividend actually divided among the shareholders in any year after Payment to them of a dividend ~~actually divided among the shareholders~~ at the rate of £5 per cent per annum on the share capital for the time being actually paid up. of the Co shall have been made in manner hereinafter more particularly specified & so that etc etc

give up good will, - they give us £10 000 advance royalties for this,

If 1st year Stockholder get no 5 pc & earn 10 pc next year we get nothing

WE don't get anything until our part of div has paid £5000 £10 000 £10 000 with interest at 5 pc from date payment

also the £10 000 from glasgow to be added to above - only get 1/2 of £5000 - EHgs taken out

Lamps used in the		Photometric intensity measured		Capacity of the calorimeter in pounds	Increase of temperature in degrees Fahrenheit	Work per minute in foot-pounds	Average number of candles per one horsepower electricity.	Average number of gas burners of 16 candles per one horsepower electricity	Average number of gas burners per indicated horsepower.
Calorimeter	Photometer	in the right angle to the paper L	Section R						
201	500	17.5	13.1	2.57	1.75°	3486	109.0	6.8	4.8
500	201	13.5	10.1	2.82	1.62°	3540			
500	201	38.5	28.9	2.74	2.44°	5181	204.0	12.8	8.9
201	500	44.6	33.5	2.76	2.29°	4898			
850	809	19.0	14.3	2.81	1.14°	2483	133.4	8.3	5.8
809	850	12.2	9.2	2.79	1.54°	3330			
817			17.2	2.73	1.28°	2708	209.6	13.1	9.2

Electrotechnische Zeitschrift
No. 9. September 1880.

CHARLES BATCHELOR COLLECTION

1881

NEW YORK CITY AND NORTHERN
RAILROAD COMPANY,
8 BROAD STREET.

New York, Jany 12th 1881

Charles Batchelor
In a/c with C. Goddard

For proceeds Edison Electric Light Stock
as follows viz:

10 shares @ $950 net		9.500
1 " " "		950.
10 " $1.000 "		10.000
		$20.450

10th 8 m U.S. Reg 4½% Bonds
bot of Soutter & Co 112 3/8 & 1/16
$8.995

12th 10 m same of Winslow
Lanier & Co 112 5/8 & 1/16 11.268.75 20.263.75

Balance due C Batchelor $186.25

I have delivered my own stock in satisfaction of above sales, to be replaced to me by Mr Batchelor. The Bonds have been sent to Washington by Miss Soutter & Co 78 Broadway & Winslow Lanier & Co for transfer to Rosanna Batchelor & will be delivered to me on return

C. Goddard

THE EDISON ELECTRIC LIGHT CO.,
3 BROAD STREET.

NORVIN GREEN, PRES.
R. M. GALLAWAY, V. PRES.
E. F. FARRIS, TREAS.
C. GODDARD, SECY.

New York, January 19th 1881

Charles Batchelor Esq
Menlo Park N.J.

Dear Sir

Under the recent increase of Capital Stock you are entitled as owner of 105 shares of original stock to 60% new stock, being 63 shrs. The amount due thereon at par (being $6.300) having been paid by Mr T. A. Edison, I now enclose the new stock, being certificates as follows:

#786 - 5 shares	which with Certificates for 21 shares sent you through Mr. Carmen on the 15th inst completes the amount. Please acknowledge receipt -
787 - 5 "	
788 - 5 "	
793 - 5 "	
794 - 5 "	
795 - 5 "	
796 - 5 "	
797 - 5 "	
798 - 1 "	
800 - 1 "	
42 shares	

Yours truly
C. Goddard Secy

THE EDISON ELECTRIC LIGHT CO.,
8 BROAD STREET.

NORVIN GREEN, PRES.
R. M. GALLAWAY, V. PRES.
E. P. FARRIS, TREAS.
C. GODFREY, SEC'Y.

New York, Jany 19th 1881

Charles Batchelor Esq
Menlo Park

Dear Sir

As owner of 5 shares of the original Capital Stock of this Company Mr Batchelor is entitled to 60% thereof - 3 shares in the increased stock of the Company at par - Mr Edison having paid the amt due thereon ($300) I enclose herewith Ck $801 for the 3 shares new stock in her name -

Please acknowledge receipt -

Yours truly

C. Godfrey
Sec'y

Boat
New York to Liverpool
Folkestone to Boulogne
Como to Stratta & return
Boulogne to Folkestone
Liverpool to New York

Liverpool to Llandudno
Via Birkenhead
ditto and return
Llandudno to London & return
London to Highgate & return
" " Crystal Pal & return
" " Folkestone & return
Boulogne to Paris & return
Paris to Naples
Naples to Florence
Florence to Venice

Venice - Turin
Milan to Como & return
Turin to Geneva
Geneva to Culoz
Culoz to Paris
Llandudno to Manchester & return
Manch. to Liverpool & return
Llandudno to Middlesboro & return

Cornelly

61 Clarkgrove Rd
Clarkhouse Lane
Sheffield
April 25th 1881

Dear Mr. Batchelor,

In a letter recd. from my Father yesterday he says that you are in Manchester & are thinking of coming over to Sheffield to go through some of the steel works.

Mrs. Cornelly myself would be very glad to see you ~~beat~~ our house & for you to spend

the night with us.
I should therefore be glad
when you come ~~to~~ over if you
would call on me at
Firth College, ~~&~~ if you should
not find me in to come on
to the above address..
If you would drop me line
as to the time & day you ~~purpose~~
purpose coming I would
try & meet you at the
station
With kind regards
I remain
Yours sincerely
Thos Carnelley

Introducing Chas. Batchelor as Edisons representative in France. Notation by French Consul. Signed by Edison. Notarized by Meadowcroft. Witnessed by [illegible] Insull.

Pardevant Me W. H. Meadowcroft notaire à the City of New York a Comparu

Mr. Edison

Lequel a, par ces présentes, donné pouvoir à M. Charles Batchelor of No. 33 Avenue de l'Opera, Paris, France.

De pour lui et en son nom

1° Faire tous apports à la Société actuellement en formation sous la dénomination de Compagnie Continentale Edison, ou sous telle autre dénomination qu'il conviendra à M. Porges fondateur de ladite Société d'adopter; apporter notamment à lad. Société toutes les inventions de M. Edison, toutes celles qu'il pourra encore faire pendant cinq ans, et enfin toutes celles qui pourront être découvertes par lui pendant douze ans, à l'expiration des cinq années dont vient d'être parlé et ayant trait à la mesure, à la distribution, et à l'application des Courants électriques, pour la production de la lumière électrique et de la force motrice.

Apporter, en conséquence, tous brevets, brevets de perfectionnements, certificats d'addition pris ou à prendre; obliger le comparant à remettre tous les dits brevets à la Société.

Faire l'dit apport aux charges, clauses et conditions que le mandataire avisera; stipuler notamment l'attribution à M. Edison de 72% dans les bénéfices nets de la Société, après prélèvement sur les bénéfices de 5% pour la réserve légale et de 15% pour le Conseil de Administration.

Stipuler que ces 72% ne seront attribués qu'après le remboursement intégral du Capital actions.

Approuver tous Statuts, signer tous actes déclaratifs d'apport des brevets, brevets de perfectionnements et certificats d'addition.

2° Intervenir dans tous actes de fondation de la en formation sous le titre de: Société industrielle et manufacturi

ou sous telle autre dénomination qu'il conviendra à M. Porges de choisir; signer tous statuts, déclarations de souscription et de versement; stipuler toute attribution de parts dans les bénéfices à venir de la Société.

3° Intervenir dans tous actes de fondation de la Société en formation sous le titre de: Société Electrique Edison ou sous telle autre dénomination, qu'il conviendra à M. Porges de choisir; signer tous statuts, déclarations de souscription et de versement; stipuler toute attribution de parts dans les bénéfices à venir de la Société.

Aux effets ci-dessus, passer et signer tous actes, élire domicile, substituer dans tout ou partie des présents pouvoirs, et généralement faire le nécessaire

Dont acte.

Les présents pouvoirs sont donnés à l'effet de se conformer à la convention rédigée et signée le 15th November, A. D. 1881, par Mess. Charles Porges et Elie Léon de Paris, d'une part, et M. Thomas A. Edison de Menlo Park, New Jersey, et La Société Electrique Edison d'Europe, Limitée, de New York, d'autre part, la dite convention expliquant le sens et la portée des présents pouvoirs.

Witnesses to the signature of Thomas Alva Edison

Wm H Meadowcroft

Saml Insull

Thomas Alva Edison

United States of America
State of New York
City and County of New York } ss:-

On this twenty third day of December, A. D. 1881, before me personally appeared Thomas Alva Edison, to me known and known to me to be the person described in and who executed the foregoing instrument and acknowledged to me that he executed the same for the uses and purposes therein set forth.

Wm H. Meadowcroft
Notary public
New York County.

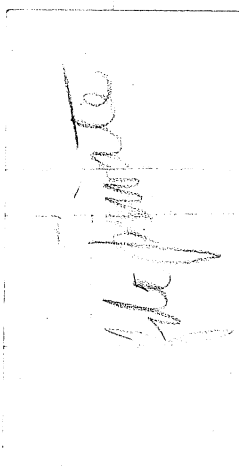
N-Y 16 47
QUITTANCE
171
12
PERÇU Douze
Poster
$2.29

Vu au Consulat Général de France à New York pour légalisation de la signature ci-dessus de M. Wm H. Meadcroft notaire en cette ville New York 24 Xbre 1881

pour le Consul Général empêché et par délégation
Le Consul suppléant
M Cruy

CONSULAT GENERAL DE FRANCE
RÉPUBLIQUE FRANÇAISE
NEW-YORK

[1881-1882]



Le Lipsie

81 rue de Monceau
Monday morning.

Dear Sir,

You will have seen by my letter of Saturday addressed to Mr. Boilay and to you that the powers drawn by Mr. Bandrier my Notary have not been sent back from New York though I had a telegramm from Mr. Lowrey telling me positively that they would be sent. I only agreed to make payments to you because I thought that the 3 societies would be immediately constituted; but the hesitations of your New York friends induce me to think that they have not sufficient confidence neither in myself nor in yourself and Mr. Boilay since they are afraid to send you powers. I therefore have decided to pay nothing before the 3 societies will be really constituted; I am quite ready to constitute them; it is your business to procure yourself sufficient powers.

Yours truly Charles Pugès

22

THOMAS A. EDISON,
No. 65 FIFTH AVENUE,

CABLE ADDRESS, "EDISON, NEW YORK."

Omitted from letter

NEW YORK, 188

one field magnet longer. It is to be insulated with twelve layers of japanned parchment paper and the air will be injected in the centre a separation being made between the field magnets: it will give 1000 light

I forgot to say that the lamps you have are 140 ohms instead of 125 ohms resistance. This was Dr Nichols mistake. After making about 30000 of these lamps everybody supposed them to be 125 ohms I got to figuring one night and found that if a lamp requires 103 volts with an economy of ten per horse power it would have to have more resistance than 125 ohms or else there must be too many foot pounds on it for a ten per horse power economy. I spoke to Upton about it and upon investigation he traced it to Dr Nichols. The Dr has left us & is now filling a Professors chair in some provincial college - "teaching the young idea how to shoot."

Tell Ennis to look out for water in his cylinder and always open the drain cocks and get dry steam and heat the cylinder up very slowly

CHARLES BATCHELOR COLLECTION

1882

COMPAGNIE CONTINENTALE

EDISON

Société anonyme, Capital : UN MILLION de francs

STATUTS

Reçus par Mes Baudrier et Mégret, Notaires à Paris,
le 2 Février 1882

PARIS
IMPRIMERIE Ve ÉTHIOU-PÉROU
RUE DAMIETTE, 2 ET 4

1882

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le 2 Février 1882

PARIS

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RUE DAMIETTE, 2 ET 4

—

1882

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STATUTS

DRESSÉS PAR ACTE REÇU PAR Mes BAUDRIER ET MÉGRET
NOTAIRES A PARIS, LE 2 FÉVRIER 1882

TITRE I

Formation et objet de la Société. — Dénomination.
Siège. — Durée.

ARTICLE PREMIER.

Il est formé par ces présentes, entre les propriétaires des actions qui vont être ci-après créées, une Société anonyme aux conditions imposées par la loi du 24 juillet 1867.

ART. 2.

La Société a pour objet :

1° D'assurer la mise en valeur des brevets ris ou à prendre dans les différents pays de l'Europe ci-après désignés, pour les inventions de M. Edison, pour mesurer, distribuer et appliquer les courants électriques pour la production de la lumière électrique et la transmission de la force motrice, et généralement l'exploitation commerciale et industrielle, même par l'établissement

d'agences et de succursales dans les différents pays d'Europe ci-après indiqués, de tous brevets et certificats d'addition ou de perfectionnement pris ou à prendre, comme il est dit article 6 concernant la distribution des courants électriques, la production et la transmission de la lumière électrique et de la force motrice;

2° La vente desdits brevets et la cession de licences; en un mot, la mise en valeur, sous quelque forme que ce soit, desdits brevets, mais sous les conditions qui seront stipulées aux présentes.

3° La fabrication et la vente du matériel et appareils nécessaires à l'exploitation des inventions de M. Edison et les perfectionnements qui pourraient y être apportés pour la production de la lumière et la transmission de la force motrice et, d'une manière générale.

ART. 3. L'éclairage électrique à incandescence et à l'arc voltaïque ainsi que toutes les applications de l'électricité pour l'éclairage et la transmission de la force motrice.

La Société prend la dénomination de : **Compagnie continentale Edison.**

ART. 4.

La durée est fixée à cinquante ans, du jour de sa constitution.

Cette durée pourra être prorogée, par décision de l'Assemblée générale, dans les formes qui seront déterminées ci-après.

ART. 5.

Son siège est établi à Paris, 27, rue de la Chaussée-d'Antin.

Il pourra être transféré dans tout autre endroit dans Paris, par simple décision du Conseil d'administration.

Des succursales pourront être établies par le Conseil d'administration ou bon lui semblera.

TITRE II

Apports.

ART. 6.

§ 1er.

MM. BATCHELOR, BAILEY et PUSKAS, au nom de M. EDISON et de la *Light Company*, conjointement et solidairement,

Apportent à la présente Société et sans autre garantie que celle de leur existence tous les brevets déjà pris pour les inventions de M. Edison, ainsi que pour tous objets ou appareils devant être utilisés pour la lumière électrique, ainsi que tous brevets de perfectionnement, certificats d'addition, et enfin tous brevets pour les nouvelles inventions à prendre pendant cinq ans, à compter du jour de la constitution de la présente Société, mais seulement dans les pays suivants :

1° La France et les colonies françaises ;

2° La Belgique ;

3° Le Danemark;

4° L'Empire d'Allemagne;

5° L'Autriche et la Hongrie;

6° La Russie;

7° L'Italie;

8° L'Espagne (les colonies espagnoles exceptées).

Les mandataires de M. Edison et de la *Light Company*, faisant réserve expresse, au profit de leurs mandants, des brevets pris ou à prendre, brevets de perfectionnement ou certificats d'addition dans le royaume uni de Grande-Bretagne et d'Irlande, le Portugal, la Suède et la Norvège, pour les inventions dont est ci-dessus question.

De plus, les mandataires de M. Edison et de la *Light Company* engagent ceux-ci pendant cinq ans, à partir du jour de la constitution de la présente Société, à donner à cette Société toutes descriptions et tous dessins ou modèles qui pourront être nécessaires pour la prise de brevets pour toutes inventions ou tous perfectionnements dans tous les pays d'Europe non réservés ci-dessus; en tant, bien entendu, que ces inventions et ces perfectionnements se rapporteront à la distribution des courants électriques et à la production et la transmission de la lumière électrique et de la force motrice, comme il est dit article 2.

De plus encore, à l'expiration desdits cinq ans, MM. les mandataires de M. Edison engagent celui-ci pour douze années de

plus et sans autre garantie que celle de leur existence à fournir à la Société tout ce qui pourra être nécessaire pour la prise de brevets pour les inventions faites par lui pendant cette période.

M. Edison devra offrir à la présente Société de lui faire apport desdits brevets, aux mêmes fins et dans la même mesure que pour les brevets actuellement existants; et, dans le cas où M. Edison et la Société ne pourraient s'entendre sur les avantages à faire à M. Edison, les parties s'engagent d'honneur à les faire déterminer par arbitres.

Tous ces nouveaux brevets, brevets de perfectionnements ou certificats d'addition, seront pris au nom de M. Edison; mais, en raison du présent apport, les droits de propriété de la Société dans lesdits brevets, brevets de perfectionnement ou certificats d'addition, seront les mêmes que ceux que la Société possédera sur les brevets actuels.

Tous les frais qui seront faits pour fournir des descriptions, des dessins ou modèles seront supportés par la présente Société, ainsi que tous droits et frais faits et payés pour la prise de brevets nouveaux, à partir du jour de la constitution de la Société.

Tous les brevets déjà pris et faisant partie du présent apport seront remis à la Société le jour de sa constitution définitive.

Ces brevets resteront entre les mains de la Société et seront tenus à la disposition de M. Edison et de la *Light Company*, qui auront le droit, soit d'en prendre communication sur place, soit d'en prendre communication sur récépissé et sans frais, à toute époque.

Les mandataires de M. Edison et de la *Light Company* engagent ceux-ci, quand ils en seront requis, à donner leur concours pour l'accomplissement des formalités légales nécessaires pour assurer à la Société le droit à la propriété desdits brevets, brevets de perfectionnement et certificats d'addition pris ou à prendre et qui font partie du présent apport.

De leur côté, les mandataires de la *Light Company* interdisent à la *Light Company* d'exploiter directement ou indirectement les inventions de M. Edison, en tant qu'elles ont rapport à la lumière électrique et à la force motrice, dans tous les pays d'Europe où la législation n'admet pas de brevets.

Il est bien entendu que lesdits brevets, en ce qui concerne tous autres objets que ceux ci-dessus énoncés, restent la propriété exclusive de M. Edison et de la *Light Company*, et que la présente Société n'aura la propriété exclusive desdits brevets et inventions qu'en ce qui concerne les objets ci-dessus énoncés et apportés.

§ 2

Dans le cas où les lois du pays autre que la France ne permettraient pas la division de propriété dans les brevets de la manière susdite, M. Edison et la *Light Company* devront transférer à la Société le droit exclusif à l'usage de tous ces brevets pour les objets dénommés au présent apport.

§ 3

Dans toutes ventes ou aliénations de brevets ou de droits s'y rattachant, les droits réservés par M. Édison et la *Light Company* sont expressément conservés.

La vente totale d'un ou de plusieurs brevets dans un des États d'Europe ou la concession de licence pour la totalité d'un de ces États ne sera valable qu'avec le consentement expressément donné par écrit de M. Édison et de la *Light Company*.

M. Édison et la *Light Company* se réservent, en conséquence, le droit d'accepter ou de refuser tous traités dont la Société poursuivra la réalisation, et par suite, sans cette acceptation, aucun traité ne sera valable, comme il est dit ci-dessus.

A cet effet, M. Édison et la *Light Company* devront faire connaître leur acceptation ou leur refus, soit directement, soit par leurs mandataires à Paris, dûment accrédités par eux, et ce dans les quinze jours de la notification du projet de traité qui aura été faite par la présente Société à M. Édison et à la *Light Company*, au domicile élu par ces derniers.

Cette notification pourra être faite par simple lettre-missive recommandée.

Dans le cas où M. Édison et la *Light Company*, usant de la

ficulté qu'ils viennent de se réserver, repousseraient un traité proposé par la Société, ils seront tenus de trouver preneur dans les trois mois de la date de leur refus, à des conditions plus avantageuses que celles proposées par la Société et de présenter ce preneur à l'acceptation de cette Société.

Dans ce cas, les actionnaires de la présente Société auront toujours droit à 20 °/₀ des bénéfices résultant de tous traités qui pourraient être conclus par M. Edison et la *Light Company*. Dans le cas contraire où M. Edison et la *Light Company* n'arriveraient pas dans ledit délai de trois mois à trouver preneur à des conditions plus avantageuses, les actionnaires de la présente Société auront droit, pour tous traités ultérieurement conclus par eux, aux mêmes lots que lors du premier contrat par elle proposé, à 20 °/₀ des bénéfices en plus à titre d'indemnité à forfait à payer par M. Edison et la *Light Company*, en dehors des 20 °/₀ susdits.

La Société, lorsqu'elle fera des cessions desdits brevets ou de quelques-uns d'entre eux à d'autres Sociétés, devra stipuler, à moins que les lois du pays où lesdites Sociétés seront constituées ne s'y opposent, qu'un tiers au moins des membres du Conseil d'administration, dans lesdites Sociétés cessionnaires, sera désigné par la présente Société, qui s'engage vis-à-vis de M. Edison et la *Light Company* à leur réserver la faculté de désigner au moins un Administrateur pour faire partie du tiers dont la présente Société aura la désignation.

En outre, la présente Société devra se réserver le droit de contrôler les acquéreurs de brevets ou de licences de brevets, afin qu'ils n'en usent que dans la mesure de la concession qui leur a été accordée.

§ 4.

M. Edison et la *Light Company* se réservent le droit d'intervenir avec la Société ou ses ayants droit dans tous procès en contrefaçon desdits brevets ou dans toutes autres instances relatives aux mêmes brevets que la Société jugera nécessaires d'intenter ou qui seraient intentées contre elle.

Il est spécialement entendu que les avantages qui leur ont été confirmés par la présentation à la Société et à la Light Co ne pourront faire aucun préjudice, ils ne modifient en aucunement, actuellement dans les conditions et de la façon avec un [illegible] reproduisant les brevets notés quelles brevets bénéficient ces avantages conformément à l'article 10 des conditions de brevets avec modifications et de 0, 1 centième par [illegible] à la convention [illegible] par Bailey, Batchelor et Puskas, [illegible] [illegible]

§ 5.

MM. Batchelor, Bailey et Puskas, au nom de M. Edison et de la *Light Company*, stipulent au profit de leurs mandants, à raison de leurs qualités d'inventeurs et de propriétaires des brevets apportés à la Société, le droit tout à fait personnel et incessible de s'opposer à toute fusion avec d'autres Sociétés, à tous apports ou cession de tout actif social ou de partie seulement dudit actif, ou encore à des contrats de participation avec d'autres Sociétés.

Toutefois, ce droit cesserait, sans pouvoir être recouvré, à partir du jour où M. Edison et la *Light Company* cesseront eux-mêmes d'être nominativement propriétaires d'au moins un cinquième des 80 °/₀ sur les bénéfices qui leur sont attribués par l'article 43 ci-après.

D'autre part, à partir du jour où M. Edison et la *Light Company* cesseront d'être nominativement propriétaires d'au moins ledit cinquième des 80 °/₀ sur les bénéfices attribués par l'article 43 ci-après, ils cesseront en même temps d'avoir droit aux conventions rapportées sous le paragraphe 3 du présent article.

Une personne nommée par M. Edison et la *Light Company* comme leur représentant pourra toujours assister à toutes les réunions du Conseil d'administration de la présente Société, mais avec voix consultative seulement.

MM. Batchelor, Bailey et Puskas ont à l'instant représenté aux notaires soussignés l'état des brevets français et étrangers apportés en Société par M. Edison et la *Light Company*, lequel état, dressé sur une feuille de timbre de 1 franc 80 centimes, non encore enregistré, mais qui le sera en même temps que les présentes, est demeuré ci-annexé, après avoir été certifié véritable par MM. Batchelor, Bailey et Puskas et après que mention de son annexe a été faite dessus par les notaires à Paris soussignés.

En ce qui concerne les brevets français, transcription du présent apport sera faite à la Préfecture de la Seine aussitôt après cette constitution, le tout aux frais de la présente Société.

En ce qui concerne les brevets étrangers, la présente Société fera son affaire personnelle, aussitôt après sa constitution, de toutes les formalités légales nécessaires à remplir pour assurer l'exécution de l'apport fait à la présente Société par M. Edison et la *Light Company*.

En représentation de l'apport qui précède, il est attribué à M. Edison et à la *Light Company* une part de bénéfices, comme sera dit à l'article 43 ci-après, et une redevance de vingt cinq centimes par lampe à incandescence, ~~comme il sera dit à l'art. 44 ci-après~~ bénéfices et redevance attachés aux parts de fondateurs comme est dit art. 44 ci-après.

TITRE III

Capital social.

ART. 7.

Le Capital social est fixé à dix millions de francs divisé en 20.000 actions de 500 francs chacune.
2000 actions ~~[illegible]~~ entièrement libérées seront remises aux porteurs des 400 actions de 500f actuellt existantes de la présente Société;
5000 actions entièrement libérées seront remises à la Société Electrique Edison et à la Société Industrielle Edison en représentation de leur apport à la présente Société.

Les 13000 autres actions sont ~~[illegible]~~ en numéraire. ~~[illegible]~~ elles sont libérées de moitié au moins....

La Société aura toujours, et à toute époque, le droit d'augmenter son Capital ainsi qu'il va être stipulé dans l'art. suivant.

ART. 8.

Le capital social pourra être augmenté une ou plusieurs fois.

par décision de l'Assemblée générale des actionnaires, sur la proposition du Conseil d'administration.

Le Conseil fixera les conditions des émissions nouvelles.

La préférence pour la souscription aux nouvelles actions est réservée, savoir :

Un quart aux souscripteurs des actions qui vont constituer le capital primitif de la Société, en proportion de leurs souscriptions ou à leurs ayants droit ;

Un quart au Conseil d'administration en exercice lors de l'augmentation du capital social, afin de lui permettre de parer aux besoins du service ;

Le Conseil d'administration déterminera, du reste, le mode de placement de ce quart,

Et moitié aux propriétaires des actions constituant le capita social à l'époque de chaque augmentation, dans la proportion du nombre d'actions possédées par chacun d'eux.

Ceux qui n'auraient pas droit à une action entière pourront se réunir pour exercer leur droit dans les conditions qui seront déterminées par le Conseil d'administration.

ART. 9.

Les actions sont détachées d'un registre à souche, revêtues d'un numéro d'ordre et signées par deux Administrateurs ou par un Administrateur et un délégué du Conseil d'administration.

En attendant la délivrance des titres, des récépissés provisoires sont délivrés aux souscripteurs des actions.

Les actions sont nominatives ou au porteur, au choix de l'ayant droit.

La propriété des titres nominatifs est établie par une inscription sur les registres de la Société.

Leur cession s'opère, conformément à l'article 36 du Code de commerce, par une déclaration de transfert inscrite sur les registres de la Société et signée par le cédant et le cessionnaire ou leurs fondés de pouvoirs, et l'un des Administrateurs.

La cession des titres au porteur s'opère par la simple tradition du titre.

Tous les frais résultant du transfert sont à la charge de l'acquéreur.

La Société peut exiger que la signature et la capacité des parties soient certifiées par un officier ministériel.

Les titres sur lesquels les versements échus ont été effectués sont seuls admis au transfert.

ART. 10.

Chaque action donne droit dans la propriété de l'actif social à une part proportionnelle au nombre des actions émises, et elle participe aux bénéfices sociaux dans les proportions qui seront indiquées ci-après.

ART. 11.

Les actionnaires ne seront engagés que jusqu'à concurrence du montant de chaque action, au delà duquel tout appel de fonds est interdit.

ART. 12.

Toute action est indivisible.

La Société ne reconnaît qu'un propriétaire pour une action. Tous propriétaires indivis d'actions sont tenus de se faire représenter par un seul d'entre eux.

Les représentants ou créanciers d'un actionnaire ne peuvent, sous aucun prétexte, provoquer l'apposition des scellés sur les biens et valeurs de la Société, ni en demander le partage ou la licitation. Ils sont tenus de s'en rapporter aux inventaires sociaux et aux délibérations de l'Assemblée générale.

ART. 13.

Les dividendes de toute action, soit nominative, soit au porteur, sont valablement payés au porteur des titres ou du coupon.

ART. 14.

Tout actionnaire qui a perdu son certificat d'inscription d'action nominative, par quelque événement que ce soit, peut, en justifiant de sa propriété et de la perte de son certificat, se faire remettre par la Société un duplicata du titre perdu.

Ce duplicata ne sera délivré que six mois après notification, par acte extrajudiciaire, à la Société et insertion dans un journal d'annonces légales du département de la Seine de la perte du titre.

Le duplicata sera inaliénable pendant cinq ans, à dater de l'insertion ci-dessus mentionnée, et les intérêts et dividendes ne seront payés que trois années après ladite insertion.

L'inaliénabilité de l'action sera inscrite sur le duplicata.

Toutefois, l'actionnaire qui voudra vendre ses actions avant l'expiration du terme de cinq années ci-dessus fixé sera tenu de fournir à la Société une caution égale à la valeur des actions et aux dividendes et intérêts calculés pour les années restant à courir, d'après les intérêts et dividendes distribués pendant les trois années qui ont précédé la perte du titre.

A l'égard des titres au porteur, il sera procédé conformément à la loi du 15 juin 1872.

TITRE IV

Administration de la Société. — Conseil d'administration.

ART. 15.

La Société est administrée par un Conseil composé de trois membres au moins et de douze membres au plus.

Les membres du Conseil d'administration sont nommés par l'Assemblée générale, sauf ce qui sera dit à l'article 16 ci-après pour les trois premières années.

Le Conseil, même le premier, peut toujours se compléter provisoirement, sauf ratification par la prochaine Assemblée générale.

ART. 16.

~~Par dérogation à l'article qui précède~~, le premier Conseil d'administration ~~sera composé de~~ la Société ~~de~~ double au capital de 50.000.000 de fr sera toujours de :

MM. BAILEY,

BATCHELOR,

~~Edmond Debry~~,

Georges LEBRET,

Elie LÉON,

MAGNIN,

Charles PORGÈS,

~~PERCEL~~,

RAU.

S.

Les fonctions de ces Administrateurs statutaires dureront trois années.

Ils peuvent être réélus.

ART. 17.

A l'expiration de la durée des fonctions des Administrateurs statutaires, les Administrateurs seront nommés pour cinq années, sauf l'effet des renouvellements dont il va être parlé.

Le renouvellement a lieu à raison de deux membres chaque année, et par voie de tirage au sort pendant les quatre années qui suivront les trois premières.

La huitième année, s'il y a lieu, tous les membres non désignés antérieurement par le sort seront soumis de droit à la réélection.

Le renouvellement aura lieu ensuite par ancienneté.

Tout membre sortant peut être réélu.

Tout Administrateur nommé en remplacement d'un autre ne

reste en fonctions que jusqu'à l'époque où devaient expirer les fonctions de celui qu'il remplace.

ART. 18.

Chaque Administrateur doit être propriétaire de ~~deux~~ trente actions. Dans la huitaine de sa nomination, il doit déposer dans la caisse sociale ces actions, qui sont inaliénables pendant la durée de ses fonctions et affectées, conformément à l'article 26 de la loi du 24 juillet 1867, à la garantie des actes de sa gestion.

Les titres de ces actions sont nominatifs et frappés d'un timbre indiquant l'inaliénabilité.

ART. 19.

Chaque année, le Conseil nomme parmi ses membres un Président, un Vice-Président et un Secrétaire. Ce dernier peut être pris en dehors du Conseil.

En cas d'absence ou d'empêchement du Président ou du Vice-Président, le Conseil désigne celui de ses membres qui doit remplir les fonctions de Président.

Le Président et le Vice-Président peuvent toujours être réélus.

ART. 20.

Le Conseil se réunit au siège social aussi souvent que les intérêts de la Société l'exigent et au moins deux fois chaque mois.

La présence de trois membres au moins est nécessaire pour la validité des délibérations; mais, dans ce cas, les membres présents devront être munis des pouvoirs de leurs collègues, de façon que les votes exprimés représentent au moins les deux tiers du Conseil, cette proportion des deux tiers étant nécessaire pour rendre valable toute décision prise par le Conseil.

Les délibérations sont prises à la majorité des voix des membres présents ou représentés; en cas de partage, la voix du

Président est prépondérante. Tout Administrateur peut donner ses pouvoirs à l'un de ses collègues ; cependant, un membre du Conseil ne peut avoir plus de deux voix, y compris la sienne.

ART. 21.

Les délibérations du Conseil d'administration sont constatées par des procès-verbaux signés par le Président et un autre membre. Les copies ou extraits de ces délibérations, à produire en justice ou ailleurs, sont signés par le Président ou, à son défaut, par un Administrateur délégué à cet effet.

ART. 22.

Les membres du Conseil d'administration reçoivent des jetons de présence dont la valeur est fixée par l'Assemblée générale.

ART. 23.

Le Conseil d'administration est investi des pouvoirs les plus étendus pour l'Administration et la gestion de toutes les affaires de la Société.

Il a notamment les pouvoirs suivants, lesquels sont énonciatifs et non limitatifs :

Il nomme et révoque tous agents et employés de la Société ; il fixe leurs salaires, leurs émoluments et leurs gratifications, s'il y a lieu.

Il règle et arrête les dépenses générales de l'administration et pourvoit à l'emploi des fonds disponibles.

En cas de nouvelles émissions, il fixe l'époque et règle le mode de versement des actions.

Il statue sur toutes les opérations faisant l'objet de la Société.

Il autorise tous achats ou ventes de brevets ou licences.

Il autorise tous achats, ventes et échanges, baux et locations de biens meubles et immeubles nécessaires aux besoins de la

Société ; il peut accepter toutes garanties hypothécaires et, au besoin, autoriser toutes acquisitions de valeurs mobilières et d'immeubles en extinction partielle ou totale des créances.

Il peut contracter tous emprunts par voie d'ouverture de crédits ou autrement, et conférer toutes garanties, même hypothécaires.

Il passe tous traités et marchés de toute nature.

Il décide, s'il y a lieu, pour la Société, d'intenter toutes actions en justice et d'y défendre ; il peut transiger, compromettre sur tous les intérêts de la Société ; il touche toutes les sommes dues à la Société.

Il consent tous désistements de privilèges, hypothèques, actions résolutoires et autres droits de toute nature; donne mainlevée de toutes inscriptions, saisies, oppositions et autres empêchements, le tout avec ou sans paiement.

Il arrête les comptes qui doivent être soumis à l'Assemblée générale et propose la répartition du dividende.

Il convoque les Assemblées générales ; il soumet à l'Assemblée générale les propositions de modifications ou additions aux présents Statuts, d'augmentation ou réduction du fonds social, ainsi que les questions de prorogation, fusion ou dissolution anticipée de la Société, ainsi que les questions relatives à tout contrat de participation.

Il statue sur tous les intérêts qui rentrent dans l'administration de la Société.

ART. 24.

Le Conseil d'administration peut déléguer tout ou partie de ses pouvoirs à un ou plusieurs de ses membres, ou à l'un ou l'autre des Directeurs, ou à une personne étrangère, par un mandat spécial, pour des objets déterminés et pour un temps limité. Il pourra choisir parmi les membres du Comité de Direction et des membres composant le comité de contrôle les fonctionnaires

Le Directeur assiste aux séances du Conseil d'administration, avec voix consultative, toutes les fois qu'il y est appelé par le Conseil.

~~Administration nommé parmi les actionnaires~~ sur la recommandation des comités, indépendamment du Président des Administrateurs pourra être fixé par le Conseil d'Adm.ⁿ à un chiffre ne dépassant pas quarante mille francs par an.

ART. 25.

Conformément à l'article 32 du Code de commerce, les membres du Conseil d'administration ne contractent, à raison de leur gestion, aucune obligation personnelle ni solidaire ; ils ne répondent que de l'exécution de leur mandat.

TITRE V

Des Commissaires.

ART. 26.

Il est nommé chaque année, en Assemblée générale, un ou plusieurs Commissaires, actionnaires ou non, conformément à l'article 32 de la loi du 24 juillet 1867.

Ce ou ces Commissaires exercent la mission de vérification ou de surveillance et tous les pouvoirs définis en la dite loi.

Il leur est alloué une rémunération dont l'importance est fixée par l'Assemblée générale.

TITRE VI

Assemblées générales.

ART. 27.

L'Assemblée générale, régulièrement constituée, représente l'universalité des actionnaires.

Les délibérations de l'Assemblée générale, prises conformément aux Statuts, obligent tous les actionnaires, même absents ou dissidents.

ART. 28.

Il est tenu chaque année, dans le premier semestre, une Assemblée générale au siège social ou dans le local désigné par le Conseil d'administration.

En outre, l'Assemblée peut être convoquée extraordinairement par le Conseil d'administration et, en cas d'urgence, par le ou les Commissaires.

Les convocations aux Assemblées générales ordinaires et aux Assemblées générales extraordinaires sont faites par un avis inséré, vingt jours au moins avant le jour de la réunion, dans un des journaux d'annonces légales du département de la Seine.

ART. 29.

Les Assemblées générales ordinaires et les Assemblées générales extraordinaires se composent de tous les actionnaires possédant, depuis quinze jours au moins avant la date fixée pour la réunion de l'Assemblée, ~~deux~~ actions libérées de tous les versements échus ou appelés.

Tout propriétaire d'au moins ~~deux~~ actions peut se faire représenter par un mandataire actionnaire membre de l'Assemblée.

ART. 30

Les propriétaires d'actions au porteur, pour avoir le droit d'assister ou de voter aux Assemblées générales, doivent déposer leurs titres au siège de la Société quinze jours avant leur réunion.

Il leur est délivré, en échange, une carte d'admission à l'Assemblée générale, laquelle carte sera nominative et personnelle.

ART. 31.

L'Assemblée générale est régulièrement constituée lorsqu'elle est composée d'un nombre d'actionnaires représentant le quart au moins du capital social.

ART. 32.

Dans le cas où, sur une première convocation, l'Assemblée générale ordinaire ou extraordinaire, sauf celle prévue par l'article 37, ne réunirait pas le quart des actionnaires, il serait procédé à une seconde convocation à huit jours d'intervalle, et le délai entre la convocation et la réunion serait, pour ce cas, réduit à dix jours.

art. séparé

Les décisions prises par cette seconde réunion seront valables, quel que soit le nombre des actionnaires et des actions représentés, mais elles ne peuvent porter que sur les objets à l'ordre du jour de la première Assemblée.

ART. 33.

L'ordre du jour est arrêté par le Conseil d'administration.

Il n'y est porté que les propositions émanant du Conseil ou qui ont été communiquées au Conseil dix jours au moins avant la réunion, avec les signatures d'actionnaires possédant ensemble un quart du capital social.

ART. 34.

L'Assemblée générale est présidée par le Président du Conseil d'administration et, en cas d'empêchement ou d'absence, par un Administrateur désigné par le Conseil.

Les deux plus forts actionnaires présents sont appelés à remplir les fonctions de Scrutateurs.

Le Bureau désigne le Secrétaire.

ART. 35.

Les délibérations sont prises à la majorité des voix des membres présents.

Chacun d'eux a autant de voix qu'il représente de fois ~~dix~~ vingt

actions, soit par lui-même, soit comme mandataire, mais sans pouvoir, en aucun cas, réunir plus de vingt voix.

Les votes ont lieu au scrutin, lorsqu'il est demandé par dix membres au moins.

ART. 36.

L'Assemblée générale annuelle entend le rapport des Commissaires sur la situation de la Société, sur le bilan et sur les comptes présentés par les Administrateurs.

Elle discute et, s'il y a lieu, approuve les comptes.

Elle fixe le dividende à répartir.

Elle nomme les Administrateurs et les Commissaires.

Elle délibère et statue souverainement sur tous les intérêts de la Société et confère au Conseil d'administration tous les pouvoirs supplémentaires qui seraient reconnus utiles.

ART. 37.

L'Assemblée générale extraordinaire peut, sur l'initiative du Conseil d'administration, apporter aux présents Statuts les additions et modifications dont l'utilité sera reconnue.

Elle décide notamment :

1° L'augmentation ou la réduction du fonds social.

Toutefois, aucune diminution du capital actuel ne pourra avoir lieu, si ce n'est par le fait de l'amortissement sur les bénéfices.

2° La prolongation ou la dissolution anticipée de la Société.

Cependant, la dissolution ne pourra jamais être prononcée que pour cause de perte des trois quarts du capital social.

3° La fusion avec d'autres Sociétés constituées ou à constituer.

4° L'apport ou la cession de tout l'actif social ou de partie seulement dudit actif, ainsi que les contrats de participation avec d'autres Sociétés.

Toutefois, pour ce qui concerne les décisions à prendre au

sujet des faits prévus sous les numéros 3 et 4 ci-dessus, l'Assemblée générale ne pourra statuer que sous les conditions stipulées au paragraphe du capital social sous le paragraphe cinquième de l'article 6 qui précède.

Dans les divers cas stipulés sous le présent article, l'Assemblée générale ne sera régulièrement constituée que si elle est composée d'un nombre d'actionnaires représentant la moitié au moins du capital social.

ART. 38.

Les délibérations de l'Assemblée générale sont constatées par des procès-verbaux inscrits sur un registre spécial et signés des membres du Bureau ou de la majorité d'entre eux.

Une feuille de présence, contenant les noms et domiciles des actionnaires membres de l'Assemblée et le nombre d'actions dont chacun est porteur, est certifiée par le Bureau et annexée au procès-verbal.

ART. 39.

Les copies ou extraits à produire, en justice ou ailleurs, des délibérations de l'Assemblée, sont signés par le Président du Conseil ou, à son défaut, par un Administrateur délégué à cet effet.

TITRE VII

État de situation. — Inventaire. Partage des bénéfices.

ART. 40.

L'année sociale commence le 1er janvier et finit le 31 décembre. Par exception, le premier exercice comprendra le temps écoulé depuis la constitution de la Société jusqu'au 31 décembre 1882.

ART. 41.

Le Conseil d'administration dresse, chaque semestre, un état sommaire de la situation active et passive de la Société.

Cet état est mis à la disposition des Commissaires dans les délais légaux.

Il est en outre établi, chaque année, conformément à l'article 9 du Code de commerce, un inventaire contenant l'indication des valeurs mobilières et immobilières et de toutes les dettes actives et passives de la Société.

Cet inventaire est présenté à l'Assemblée générale et tout actionnaire peut en prendre, à l'avance, communication au siége social, ainsi que de la liste des actionnaires.

ART. 42.

Les produits de la Société servent d'abord à acquitter les dépenses et charges généralement quelconques de la Société.

ART. 43.

Les produits nets, déduction faite des charges, constituent les bénéfices.

Sur ces bénéfices, il est prélevé :

5 %, pour la constitution du fonds de réserve légale,

Et 11 %, pour le Conseil d'administration, qui en disposera comme bon lui semblera.

Après prélèvement du fonds de réserve légale, 5 % sur le surplus du bénéfice net pour le fonds de réserve légale

Sur le surplus il sera prélevé :

1° Une somme suffisante pour payer un intérêt de 6 % au capital versé,

2° 5 % pour former un fonds d'amortissement destiné à rembourser le capital versé par le mode et les conditions prévues par le Conseil d'administration.

En échange des actions amorties l'actionnaire recevra des actions de jouissance qui donneront droit à une part proportionnelle dans les 60 % ci-dessous attribués aux actionnaires.

Après ces dispositions le bénéfice sera distribué comme suit :

60 % aux actionnaires comme titres aux bénéfices supplémentaires, et 40 % aux porteurs de jouissances. La proportion sont inconnues quel que soit le chiffre du capital ;

part proportionnelle dans les 20 °/₀ ci-après attribués aux actionnaires et les 5 °/₀ attribués éventuellement par l'article 6.

Après le remboursement dudit capital-actions, les bénéfices nets, toujours déduction faite des prélèvements ci-dessus prévus, seront répartis comme suit :

20 °/₀ aux actionnaires, à titre de dividende ;

Et 80 °/₀ à la *Light Company* et à M. Edison, en représentation de leur apport, sauf règlement entre eux.

Ces droits seront invariables, quelles que soient les augmentations du fonds social:

ART. 44.

Les droits attribués à la *Light Company* et à M. Edison par l'article précédent sont constatés par des titres qualifiés de certificats de parts de fondateurs et dont la *Light Company* et M. Edison disposeront comme ils l'entendront. *

Une décision du Conseil d'administration, prise d'accord avec les fondateurs, déterminera ultérieurement le nombre de ces titres, qui ne donneront pas à leurs propriétaires le droit d'assister aux Assemblées générales. La forme de ces titres sera réglée par le Conseil d'administration seul.

Mais ces titres seront nominatifs ou au porteur au choix de leurs propriétaires.

Ils ne conféreront aucuns autres droits que ceux dont il a été parlé plus haut et n'engendreront aucune obligation.

Ils se transmettront par la simple tradition s'ils sont au porteur, et par transfert s'ils sont nominatifs.

Les bénéfices y afférents se paieront au porteur du titre.

Ils se prescriront par cinq ans, du jour de leur exigibilité.

ART. 45.

Le paiement des dividendes a lieu dans l'année qui suit la clôture de l'exercice auquel ils sont attribués et aux époques fixées par le Conseil d'administration.

Toutefois, pour le premier semestre de chaque année, le

* Ces parts de fondateurs, en outre des 40 % dans les bénéfices stipulés par l'art. 45 ci-dessus, recevront une redevance de 25 centimes par lampe à incandescence qui sera employée ou vendue par la Société, quel qu'en soit le système; cette redevance sera portée aux frais généraux.

Conseil d'administration est autorisé à distribuer un acompte sur les bénéfices réalisés.

ART. 46.

Tous dividendes qui n'ont pas été touchés cinq ans après l'époque fixée pour leur paiement sont prescrits et acquis à la Société.

TITRE VIII

Dissolution. — Liquidation.

ART. 47.

L'Assemblée peut toujours décider la dissolution anticipée, sur la proposition du Conseil d'administration et par trois quarts de majorité, au cas ci-dessus prévu article 37.

En cas de perte des trois quarts du capital social, les Administrateurs sont tenus de provoquer la réunion de l'Assemblée générale de tous les actionnaires, à l'effet de statuer sur la question de savoir s'il y a lieu de prononcer la dissolution de la Société.

La résolution de l'Assemblée est, dans tous les cas, rendue publique.

ART. 48.

A l'expiration de la Société ou en cas de dissolution anticipée, l'Assemblée générale règle le mode de liquidation et nomme un ou plusieurs liquidateurs.

Elle peut leur conférer tous les pouvoirs qu'elle juge convenables, même celui de faire l'apport ou la cession à une autre Société ou à un particulier de tous les biens et droits de la Société dissoute.

Les pouvoirs de l'Assemblée générale se continuent pendant la liquidation comme pendant l'existence de la Société.

Dans tous les cas de dissolution de la Société, la liquidation s'opérera par les soins du Conseil d'administration alors en exercice, à moins de décision contraire de l'Assemblée générale, qui prononcera souverainement sur les opérations de la liquidation.

Mon avant-propos de la société 5 % sur le capital

Le produit de la liquidation, après l'acquit du passif et le remboursement du capital versé, sera réparti dans les proportions suivantes :

50 % aux actionnaires ou ~~titulaires~~, jouissance d'actions de jouissance.

Et 50 % aux porteurs des parts de fondateurs.

ART. 49.

Toutes les contestations qui pourront s'élever pendant le cours de la Société ou lors de la liquidation, soit entre les actionnaires, la Société, les Administrateurs ou les Commissaires, soit entre les actionnaires eux-mêmes, relativement aux affaires sociales, seront jugées conformément à la loi et soumises aux tribunaux compétants du département de la Seine. A cet effet, tout actionnaire non résidant à Paris devra y faire élection de domicile ; à défaut de quoi, le domicile sera élu de plein droit au parquet de M. le Procureur de la République près le Tribunal civil de première instance de la Seine.

Aucune action ne pourra être intentée par un actionnaire, si elle n'a été soumise à la dernière Assemblée générale.

TITRE IX

Dispositions transitoires.

ART. 50.

Les deux Assemblées générales constitutives pourront, par

exception, être convoquées par un avis inséré dans un journal d'annonces légales du département de la Seine, savoir :

La première, trois jours à l'avance,

Et la deuxième huit jours à l'avance.

Dans le cas où elles ne réuniraient pas un nombre d'actionnaires représentant la moitié du capital social, elles ne seraient que provisoires, et il serait procédé comme il est indiqué au dernier alinéa de l'article 30 de la loi du 24 juillet 1867.

Par exception également, la première Assemblée générale ordinaire ou extraordinaire de la présente Société, qui suivra immédiatement l'Assemblée constitutive, pourra être aussi convoquée huit jours à l'avance, par un avis inséré dans un journal d'annonces légales du département de la Seine; cette convocation pourra être faite même avant la constitution de la Société.

Publications.

ART. 51.

Pour faire publier les présents Statuts, l'acte de déclaration de souscription et de versement et les délibérations constatant la constitution de la Société, tous pouvoirs sont donnés aux porteurs d'une expédition ou d'un extrait.

7438. — Paris. — Imprimerie Ve Eugène Pérou, 2 et 4, rue Hautefeuille.

EDISON MACHINE WORKS.
104 Goerck Street,

New York, March 7th 1882.

A. Batchelor, Esq.
83 Avenue de la opera,
Paris.

Dear Sir,

Thinking you would like a copy of our last years report I beg to enclose same herewith. When you remember what we went through I think the showing is remarkable.

This statement is perfectly reliable and the figures represent truly what they stand for. The only comment I would make is that you will notice that we are short of capital and consequently the amt. owed is just so much increased. B. Bros. is a perfectly good acct and is only temporary, pending settlement. Stock and Labor on hand is very largely of dynamos in different stages of construction as well as those finished of which we had a large number.

This statement if made at this writing to date would differ very materially in the liability B. Bros. what we owe, and also Stock and Labor. Enough machines from the latter have been sold to nearly wipe out the former account. We do not expect our Plant or Capital to increase very much more. I append a statement of our Capital etc to date for your information.

We hope to make a good showing for this year, and if we can only get plenty of work we can make money. Our shop ought to be crowded all the time.

Wishing you every success in your enterprize, I am,

Yours faithfully,
Charles Roesch

[ENCLOSURE]

Copy.

EDISON MACHINE WORKS,
104 Goerck Street,

New York, Jany. 1st 1882

Dr. Edison Machine Works Cr.
Balance Sheet Dec. 31. 1881.

Assets		Liabilities	
Plant	$ 160738.95	Capital	$ 147999.93
Sundry Drs. owed us	" 5760.85	Sundry Crs. we owe	" 80357.44
Stock & labor on hand	" 69083.98	Profit	" 10853.36
Cash in bank	" 3626.95		
	$ 239210.73		$ 239210.73
Gross Cash Receipts	$ 314386.88	Gross Cash Disbursements	310759.93

Explanation.

It will be seen from the above that our Capital is under our Plant by $ 12739.02. Suppose we furnish that amount of money and thus make our Plant cost just our Capital. This money we deposit in bank and added to what we have there as above it will make $ 16365.97 as available. Now if we collect what is owed us viz. $ 5760.85 and sell our stock on hand at cost just as it appears above viz. for $69083.98 It will give us in funds $74844.83 Applying this toward liquidating what we owe viz. $80357.44 It will leave us still owing $ 5512.61. But we have in the bank untouched $ 16365.97 Paying the $5512.61 out of this we have left ~~the~~ to our credit in bank $ 10853.36 which is just our profit made as shown above. Now to clear everything up sell out our our plant would certainly bring at auction $160738.95. This would exactly equal your invested capital, and you would have profit $ 10853.36 Cash in bank.

[ENCLOSURE]

100 000 000
18 000 000
3 600 000
14 400 000
3 600 000
10 800 000

100

5,800,000

100 000 000
10 000 000
20% 2 000
8 000 000
1 600 000
72 6 400 000

144 000 00
86 400 000
10 368 000

144 000 00
288

25 125
12 562.50
25 125
12 562.50
25 250
25 125
12 562.50
25 125

[ENCLOSURE]

OFFICE OF

Edison Machine Works,

104 Goerck Street,

New York, Mch. 1st 1882.

Capital Ap

Jan 1/82 T. A. E's proportion $ 33200.00

Mch 1/82 do do $ 147700.00

All paid up

Jan 1/82 C. B's proportion $ 14799.93

Mch 1/82 do do " 16411.03

C. B. paid June 30/81 $ 1000.

" " July 14 " 3000.

" " " 19 " 6000.

T. A. E. paid for ate C. B Nov 9 " 2500.

" " " " Dec 31 " 1500.

" " " " Jan 21 " 750. 14750.00

Propn. C. B's cap. not pd up Mch 1 $ 1661.03

N. & E. Léon

4 Rue Chauchat
Paris le 28 Mars 1882

Reçu de Monsieur Ch. Bâtchelor Cinq mille francs en un chèque sur Messrs Drexel Harjes & Cie

Paris 28 Mars

pr Elie Léon
Herring

TIMBRE

6, Lombard Street, E.C.

London 2nd May 1882

Dear Batchelor

I understood from Johnson that you were expected here every day, so that I have neglected to write to you about the money I have to pay you.

There are one or two papers that you will have to sign and which I would rather not trust to the Mail if you are coming here in a day or two.

The Amounts I have to pay you are on account of

United Telephone Shares	£745.7-0
Oriental Telephone -"-	£1855 - -

When may I have the pleasure of seeing you.

Yours faithfully

[illegible]

EDISON MACHINE WORKS.
104 Goerck Street,

New York, May 16th 1882.

C. Batchelor, Esq.
Ivry-sur-Seine,
France.

My dear Sir,

In accordance with Mr Edisons suggestion, I beg to hand you herewith a statement of the cost of a 'C' dynamo of our present style, for your information, comparison &c. You will note I have given weight, price &c of all important parts; but for the small items I have had to guess. The labor has been omitted owing to the wide difference in cost; but by adding your cost of labor &c. the comparison will be drawn. We have to start with a base cost of stock of nearly $5000. This no doubt will be a surprise.

Your esteemed favor of 1st inst. is just at hand, and I will be glad to mail you a copy of our semi-annual statement about middle of July.

Yours faithfully,
Chas Clerc

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
Paris 1881
GRAND DIPLOME D'HONNEUR

Paris, le 7 Juin. 1882

Par la présente nous autorisons Monsieur Charles Batchelor, administrateur de la Société Électrique Edison à signer en notre nom le contrat à intervenir entre la Municipalité de Brunn d'une part, et notre Société, de concert avec Messieurs Bruckner Roß et Consorts de l'autre.

Société Électrique Edison.

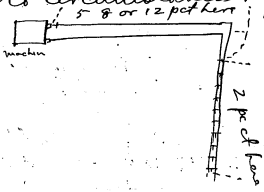
Louis Rau Charles Poiré

THOMAS A. EDISON,
MENLO PARK, N. J.

June 17 1882

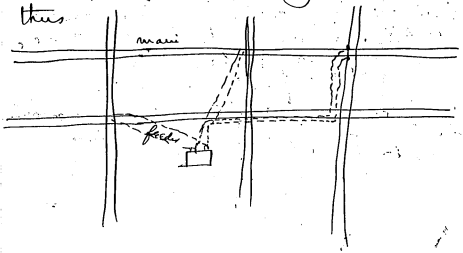
Batch -

In putting up large installations or for that matter small installations look out for the drop of pressure. Our tables are made for a loss of 5 per cent. this is 5 volts now a difference of 5 volts will make the lamp at the machine say 16 candle & the last lamp 6 candle or 25 or 30 candles at the machine and 16 on the last lamp - we have changed that here. We only allow 2 per cent loss from the 1st lamp to the last and make the loss 5-8 or even 12 per cent on the wire leading from the machine, according to circumstances. for instance



the conductor leading from the machine having no lamps on, any difference dont effect which the circuit on which the lamps are burning but 2 volts fall the difference in candle power is not over

noticeable. Now in your large installations you must look sharp after this and I think in most places you will have to calculate for a loss of 2 percent on the tubes carrying the light and ten to 12 percent on your feeder thus



a loss of 5 percent on your lamp candles would be too much — In square mile installations without a model to put up on a board & the pressure & position of feeders accurately determined & general distribution would be a failure as there would at certain hours be a difference of 15 volt which would bring some of the lamps to 40 candles

Paris. Le 29 Juin 1882

Monsieur Charles Porgès, Président du Conseil d'Administration de la Compagnie Continentale Edison et de la Société Electrique Edison.
Paris.

Nous vous informons, comme représentants de la Light-Company et de Monsieur Edison, que nous sommes d'accord avec vous pour que les bénéfices résultant des contrats à intervenir pour la cession de licences de fabrication des appareils du système Edison, reviennent exclusivement à la Compagnie Continentale Edison.

Nous ferons les démarches nécessaires pour être munis de pouvoirs en règle dans le plus bref délai.

Agréez, Monsieur le Président, nos salutations distinguées,

Theo. Vinkler

J. F. Bailey

EDISON MACHINE WORKS.
104 Goerck Street.

New York, July 20th 1882.

C. Batchelor, Esq.
Ivry sur Seine.
France.

My dear Sir,

As promised you I have now the pleasure of enclosing herewith copy of our balance sheet June 30. I also send copy of my letter to Mr Edison which explains very fully everything.

We are very busy here as you can imagine. On our pay roll this week we have 430 men about $5000.

Yours faithfully,
Charles Rocaf

[ENCLOSURE]

Copy

Edison Machine Works

Balance sheet June 30 1882

	Increase June				
Plant	8328.09	$169 530 80	Capital		$164 111 03
Isolated Stock a/c	12875.60	31 740 60	Profit & Loss. last year		14 316 38
Labor-Material	61375.88	298 825 13	a/c Sales for June 74714.21		296 588 39
Cash a/c tel May 31 receipts June	~~[illegible]~~	2470 68 92 192 88	Cash a/c disbursements on a/c of a/cs Payable 80551.99 Is. Stock 12875.60		93 427 59
a/cs Receivable bal. last mo.	33549.75	16 081 41	a/cs Payable bal. last mo.	53235.80	42 398 11
increase this transfer	74714.21 29.01		increase this	69732.98	
	108 292.97			122968.78	
receipts	92 192.88		Cash payments	80551.99	
	16100.09			42416.79	
transfer	~~29.01~~		transfer	18.68	
"	18.68		bal. this mo.	42 398.11	
bal. this mo.	16081.41				
		$610 841 50			$610 841 50

[ENCLOSURE]

EDISON MACHINE WORKS.
104 Goerck Street,

Copy

New York, July 19th 1882.

T. A. Edison, Esq.
Menlo Park, N. J.
Dear Sir,

I beg to hand you herewith balance sheet for month of June which also closes the first half of this year. Also please find accompanying the dynamo ofc. I think there is cause for congratulation on the showing made.

You will notice the capital does not equal the Plant by over $5000. Our sales are about equal their offset, the labor & material ofc, then we have on hand at the time of this balance, the following bare cost of work not paid for (not sold) about $21000. on Co. $20000. on Yo. $3000. on Ls. $5000. on Ko. $2500. freight Loco. total $51500. This of course will be turned out at some profit. Then we have $31000 in Isolated stocks. (I believe you say this is worth 200) and $14000. on profit & loss a/c last year, and 19 Yo. on hand completed $10000. This makes $106500. Now we owe $42000. less owed us $16000. $26000. net. Deduct this from $106500. and it will leave $80500. profit.

Then we are building 50 Ks. = $67500. 15 Cs. $150000. and 150 L. $135000. or $352500. worth of work on hand. Figuring on the cost of similar work heretofore, I think the 50 Ks. will cost $50000. the 15 Cs. $127000. the 150 Ls. $100000. or total cost of $ 277000. leaving about $75000 profit

Yours very resp.,
(signed) Chas E Roop

[ENCLOSURE]

Copy

EDISON MACHINE WORKS.
104 Goerck Street,

New York, July 19th 1882.

Number & class of dynamos built and sold to June 30 1882

Class	finished to May 31	finished in June	sold to May 31	sold in June	on hand June 30
C.	9	—	9	—	—
K.	10	32	6	36	—
J.	292	5	266	12	19
E.	24	—	14	6	4

FROM

THOMAS A. EDISON,

~~No. 65 FIFTH AVENUE,~~

Menlo Park, N.J.

~~New York,~~ 10 Aug 1882

TO

CHAS. BATCHELOR,

PARIS, FRANCE.

My Dear Batchelor

I do not know whether I have called your attention to the importance of preventing a fall of pressure in your Isolated Installation as well as in the General Distribution business. If with an Isolated Plant the main wires are run out from the Dynamo all through the Building there will be as you know a gradual drop and there will be a difference between the first lamp and the last lamp of five or six volts which will burn the lamps up near the Dynamo to from twenty to twenty five candles rounded a point is made of keeping those at the extreme distance from the Dynamo at sixteen candles. A difference of a few volts when both lamps are made to run at a given number of volts will make a considerable difference in the life of the lamps.

The proper way to do is to never have a loss of more than

FROM

2 THOMAS A. EDISON,

~~No. 65 FIFTH AVENUE,~~

~~New York,~~ 188

TO

CHAS. BATCHELOR,

PARIS, FRANCE.

two and at most three per cent upon the wires and mains upon which the lamps are strung. This will cause a greater investment in copper but by not connecting the Dynamo to one end of the system but by running from the dynamo out to the centre of your system you can have a loss of what you please on these feeder wires say of five or ten or any per cent you may wish without affecting the loss on the mains carrying the lamps and thus you can bring the copper down so that it needs be not more than the amount used in the present method and at the same time you can have the great advantage of only having a difference of two per cent between any two lamps on your circuit. In the installations with large steam Dynamos your calculations should be directed to taking advantage of this as it is of great importance not to have more than two or

FROM

THOMAS A. EDISON,

~~No. 65 FIFTH AVENUE,~~

~~New York,~~ 188

TO

CHAS. BATCHELOR,

PARIS, FRANCE.

or at most three volts difference between the nearest and most distant lamps and this can only be done by the feeder plan as above detailed. Johnsons installation at Holborn Viaduct should have been put down on these lines. He should have had ~~out~~ two mains the whole length of the Viaduct and then run out in each direction a feeder cutting into the mains half way on each side. This they will have to do when they increase their installation for if they attempt to load up the circuit they will find their volts will be unequal and if the lamps at the station are sixteen candles the lamps at the extremity of the circuit will not be more than seven or eight candles. It does not require very much more copper for the reason that you can calculate for a loss even as high as ten per cent on your

4

FROM

THOMAS A. EDISON,

~~No. 65 FIFTH AVENUE,~~

~~New York~~, 188

TO

CHAS. BATCHELOR,

PARIS, FRANCE.

feeders thus diminishing the copper invested in feeders as calculate the loss on your mains at 2%. The great drop on your feeders will not affect ~~the drop on your mains the lamps~~ at all as you can readily see. The feeders which they will have to run out on the viaduct may be the same size as the mains the loss on the latter being but 2% while on the feeders it may be 8% or 10%. You will see how important this matter is if you think the matter over.

You know in our Paris District in New York we find by calculating that the copper tubes would cost $125,000 with a loss of 10% which means about ten volts fall. Now ten volt fall would cause the lamps to be all kinds of candle power in different parts of the district if the loss were upon the mains direct. Hence the necessity for adopting the plan of feeders so as to have

5

FROM

THOMAS A. EDISON,

~~No. 65~~ FIFTH AVENUE,

~~New York~~ 188

TO

CHAS. BATCHELOR,

PARIS, FRANCE.

the greatest loss upon the feeders & the lessen loss upon the mains or in other words the drop in volts ~~that~~ is the drop in candle power is upon the feeders & not upon the mains and so we maintain uniformity of candle power. The cost was increased but very little by so doing because we made the mains all alike with a loss upon them of 2% and made practicable all our loss upon the feeders increasing the loss from 10% to 15% when all the lights are on so that when our District is in full play there will not be in any part of our District a difference of more than two volts between the lamps.

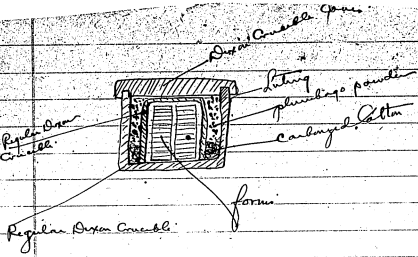
Yours truly

Thos A Edison

Batch - Menlo Park N.J.
31st August 1882

Latest dodge Carbonizing -

We are using Carbon forms & weights for holding fibres instead of Nickel and are getting even better Carbons = I will send you a sample by mail of complete form & weight so you can make dies & punch =
They are pressed in screw press little larger than ours = Use ground gas retort Carbon mixed with minimum quantity of Crude anthracene thinned slightly by Kerosene or Crude Coal tar. put a little more pressure than we did on chalks = then lay forms etc on flat iron plate & bake very gently up to say 400 or 500 fahr so they dont blister & warp then put them in your Carbonizing Covers & bring up the same as you would fibres in Nickel forms. (1st) just as slow then you are ok & will never have any more trouble about melting forms etc, We have run over 50 heats with them & they actually improve. Another thing we do we use double Covers thus



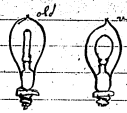
The Cotton should be carbonized first & only to a red heat it is then very sensitive to Oxygen. The object is to keep out oxygen,

with Carbon forms you can go up to as high a temperature as your fire brick will stand = we are using a special fire brick used by Wharton to melt nickel you can doubtlessly get good ones there

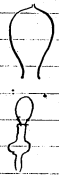
I have ordered Upton to send you wkg drawings of our new furnace we have 4 going they work splendid,

= WE are running through several hundred Lamps the Carbons of which were laid out straight in a bundle between Carbon blocks also in bundles tied with thread & carbonized afterwards the Carbon is bent as a loop & put in

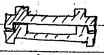
C[illegible]ps and plated, they seem to be as good as regular & make far nicer Lamps as they follow the Contour of the bulb



There is ~~[illegible]~~ no trouble putting them in bulb as the bulb is previously little bell mouthed & it acts as a squeezer



An improvement you might adopt in making your forms over ours is



overlapping this will prevent circulation of oxygen

I forgot to say that we put two fibres in one mould [illegible]

Edison

THE EDISON LAMP CO.,

East Newark, N. J., Sept. 9, 1882

Charles Batchelor Esq
Ivry-sur-Seine France

Dear Batchelor:

I enclose statements of cost of the lamps for last year and first six months of this year.

The cost last year is high as it includes all the Menlo Park experiments when starting in. The cost for the first six months of this year is high due to the moving of the factory and breaking in of new hands.

I expect to approximate 50 cts. for this six months including all expenses.

The breaking in of new hands is exceedingly expensive, as they break so many lamps. You may be having some such experience at your factory.

Next year I am going over to see you. I now act the time in July. I shall be gone six weeks. This is on

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

condition that you allow me to go all through your factory.

You will probably have all you can do to supply France with machines and lamps for the present, leaving us a good show at the Continent.

We are now making 800 A lamps a day including some 10 candle A lamps and 32 candle lamps. This is equal to 1100 A + B mixed about one half of each.

We are going to have 40 cts. cash for lamps from the Parent Co. and this will make a good business in the future. though it will be a year or two before the tide turns I am expecting.

Yours Truly

Francis R. Upton.

[ENCLOSURE]

Statement

THE EDISON LAMP CO.,

East Newark, N. J., July 1st 1882.

From January 1st 81 to January 1st 1882

Lamps manufactured		116120
Deduct unusable High volts and resistance Lamps.		11,120
		105.000
Lamps ship'd Foreign	20,242	
" Home	14500	34742
Lamps on hand July 1st 1882		70258

Cash received for Lamps Sold. $ 13175 29/100

[ENCLOSURE]

Statement

THE EDISON LAMP CO.,

East Newark, N. J. July 1st 1882.

From January 1st 1881 to January 1st 1882

Material for Lamps.	$ 61107.14
Labor.	$ 39745.62
	$ 100852.76
Material on hand Jan 1st 1882	4529.00
	96323.76
$ 115511 25/100 Capital Interest 6%	6930.68
$ 20178 15/100 Machinery & Tool. 15% Depreciation	3026.75
$ 21742 70/100 Building & Fixtures 5% and Depreciation	1087.14
	$ 107368.33

105.000 Lamps manufd
cost per Lamp. $ 1.02

[ENCLOSURE]

Statement

THE EDISON LAMP CO.,

East Newark, N. J. July 1st 1882.

Cost of 105,000 Lamps manufactured from January 1st 1881 to January 1st 1882

	Material	Cost	Labor	cost	total cost
Fibre	828.29	.0079	5780.57	.055	.0629
Carbon	4261.98	.0406	3909.08	.037	.077
Wire & Inside parts	2031.94	.0200	3150.58	.030	.050
Plating	1973.54	.0190	1253.94	.012	.031
Glass	14468.46	.137	8711.68	.083	.220
Exhausting	1305.44	.012	5054.57	.048	.060
Pumps	3390.96	.032	2932.90	.028	.060
Power.	973.93	.009	1042.82	.010	.019
Socket.	2550.38	.024	2122.85	.020	.0244
Testing	356.95	.0034	2198.73	.020	.0234
Packing	34.75	.0003	592.99	.005	.0053
Expense	24401.57	.232	29444.15	.028	.260
	56578.14	.5366	39745.62	.376	.912

$115511.41 Capital 6% Interest per lamp .066

$20,175.35 Machinery + Tool 15% Depreciation per lamp .029

$21742.70 Building + Fixtures 5% Depreciation " .010

Per lamp 1.017

[ENCLOSURE]

Statement

THE EDISON LAMP CO.,

East Newark, N. J., July 1st 1882.

From January 1st 82 to July 1st 1882

Lamps on hand Jan 1st 82		70258
Lamp manufd to July 1st	53040	
deduct High volts unsalable and resistance Lamps.	3040	50,000
		120258
Lamps shipd Foreign	34579	
" " Home	28230	62809
Lamps on hand July 1st 82		57449

Cash received for Lamp sold $35,208 08/100

[ENCLOSURE]

Statement
THE EDISON LAMP CO.,

East Newark, N. J. July 1st 1882

Cost of 50.000 Lamps manufactured from January 1st to July 1st 1882.

Material on hand Jan. 1st.	4529.00
" for Lamps.	13546.49
	18075.49
Labor.	16688.84
	34764.33
Material on hand July 1st 82	5576.00
	29188.33
$163011 41/100 Capital 6% Interest	4890.34
$19266 19/100 Machinery + Tool. 15% Depreciation	2889.93
$45647 89/100 Building + Fixtures 5% Depreciation	2282.39
	39250.99

50,000 Lamps manufd

Cost per lamp .78½

Interest on mortgage per lamp .18

80¢

[ENCLOSURE]

Statement
THE EDISON LAMP CO.,

East Newark, N. J. July 1st 1882.

Cost of 50,000 Lamps manufd
from January 1st to July 1st 1882

	Material	Cost		Labor	Cost		Total cost
Fibre	630	58	.012	1716	24	.034	.046
Carbon	891	45	.017	967	65	.019	.036
Wire & Inside parts	829	58	.0165	899	31	.0179	.0344
Plating	101	65	.002	701	71	.014	.016
Glass	5658	81	.113	2586	36	.051	.164
Exhaustion	101	99	.002	2435	66	.048	.050
Pumps.	135	46	.0027	1356	38	.0277	.0304
Power	2039	30	.040	1008	09	.020	.060
Socket	355	27	.007	1687	30	.033	.040
Testing	80	30	.0006	1315	21	.0263	.0269
Packing	184	92	.0037	688	27	.0137	.0174
Expense.	1837	19	.036	1316	72	.026	.062
	12796	49	.2525	16688	84	.3306	.583

$50,000 Mortgage 6 mo Interest @ 6%	Per lamp	.018
$163 014.41 Capital 6% Interest	" "	.097
$19266.41 Machinery & Tool 15% depreciation	" "	.057
$45447.89 Building & Fixtures 5%	" "	.045
	" "	.80

The Edison Electric Light Company, Limited,

74, Coleman Street,

London, E.C., 11TH SEPTEMBER 1882

DEAR MR. BATCHELOR,

I AM MUCH OBLIGED TO YOU FOR YOUR LETTER OF YESTERDAY AND FOR THE CUTTING FROM THE FIGARO. I TELEGRAPHED JOHNSON AND HE PROMISED ME A CABLEGRAM ABOUT THE LIGHTING, BUT I HAVE HEARD NOTHING. DO YOU KNOW ANYTHING ABOUT THE PRICE OF THE STOCK, AS MR. WADE, ONE OF OUR DIRECTORS, INFORMS ME THAT THE NEW YORK PARENT STOCK HAS BEEN SOLD IN LONDON DURING THE LAST TEN DAYS AT PAR - I AM RATHER ANXIOUS ABOUT THIS.

I AM VERY MUCH OBLIGED TO YOU FOR LETTING ME KNOW THAT THE PRESS IS READY AS IF ONLY WE CAN MAKE A LITTLE OF THE INSULITE I THINK THERE IS NO DOUBT THAT WE SHALL SELL THE PATENT WITH GREAT FACILITY AND IN DOING SO I TAKE THIS OPPORTUNITY OF SAYING THAT THE PART YOU HAVE BEEN GOOD ENOUGH TO TAKE IN FACILITATING OUR OPERATIONS WILL NOT BE FORGOTTEN.

I REMAIN ,

YOURS VERY TRULY,

[signature]

H. BATCHELOR ESQ.,
33 AVENUE DE L'OPERA,
PARIS.

Porges
Tréport 14. Septembre
1880

Cher Monsieur.

Je possède vos lettres du 12 cour. et je vous remercie des informations que vous me donnez.

La correspondance regardant les moteurs Armington & S. me paraît suffisante.

Pour ce qui regarde la dépense du „rechauffer & pump" je n'ai aucune compétence pour vous donner une réponse ; cela regarde les Ad^ens délégués de la Cie Continentale. Quant à moi il me semble que nous aurons le temps de faire des expériences sur le charbon le meilleur marché lorsque ces moteurs travailleront effectivement — mais il se peut que je suis dans l'erreur.

Je ne puis comprendre ce qui a donné lieu à votre dernière phrase : „what seems to you to have been an attempt to mislead".

Je n'ai jamais conçu ni exprimé le moindre doute dans votre entière bonne foi, qui m'est suffisamment connue ; j'ai pu dire qu'on ne pouvait compter sur l'exactitude positive des évaluations données

par les ingénieurs et il me semble que ce qui s'est passé jusqu'à présent justifie cette réserve.

Veuillez mes salutations empressées

Ch. Dupuy

Laboratory of
Thomas A. Edison
Menlo Park N.J.

15th September 1882

My Dear Batchelor,

Referring to Edison's letter to you of 13th inst Edison has told me to write you some little explanation.

Bailey says that Moses was a great deal worse than useless, that he did practically nothing, that for several weeks at a time he would absent himself & that his claims are altogether preposterous.

An identical letter was sent to you & Tucker & Bailey with the object of getting officially the exact facts of the case so as to enable Edison to shut up Moses either with the evidence of his uselessness or with a reward for his good services. Moses claims that he was at great expense in Paris that he was obliged to entertain largely, & to sum it all up that he

✓

Laboratory of
Thomas A. Edison
Menlo Park, N.J.

_____ 188_

rendered very great services to Edison & his Co'y. Bailey denies that he had to entertain for Mr Edison that he rendered but very little service indeed, that he was totally unreliable, that a great deal of time he was attending to his Photo Relief business: Moses has got from Edison $2500 on a/c. of his expenses and Edison gave him 50 shares of European Light Clock & has no intention of giving him anything more. Moses has been repeatedly asked for a detailed a/c of his expenses & to reduce his general statements as to what he wants to a demand in black & white. He has done so at last & I give you below a copy of his letter, for your information and amusement.

"memorandum

"Dear Sir New York Sept 11th 82.

"As the time has arrived for

3
7

Laboratory of
Thomas A. Edison
Menlo Park N.J.

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"a settlement of our accounts
"in regard to my visit to Europe
"for the purpose of assisting
"in disposing of your patents for
"Electric light, I beg to make the
"following statement. You asked
"me of your own accord to
"represent you at the Paris Electrical
"Exposition and by every means in
"my power to accomplish the
"desired object viz: the favorable
"sale of your European Patents
"and the general removable of
"any obstacle thereto. This I have
"done to the best of my ability
"occupying nine months of my
"time exclusively with this business.
" As compensation for my
"time and labor I beg to submit
"a charge of 2½ % on the proceeds
"resulting to you from the sale
"of said patents

Truly yours
Otto A Moses"

"T. A Edison Esq

4/

Laboratory of
Thomas A. Edison
Menlo Park, N.J.

_____ 188_

I can imagine how amused you will be on reading this epistle. I am just going into New York to see Edison about replying to it & I will advise what the reply is.

Moses is just a nuisance to Edison. In March last he kept Edison standing on a street corner till away into the night and as a consequence Edison caught cold which was one of the causes of Edisons sickness. Not content with this Moses still continues to worry Edison & I am going to make an effort to get the thing settled now beyond question. If I am not mistaken the settlement will be a refusal to do anything more. More of this later.

Yours truly

Saml Insull

[OCTOBER 22, 1882] [FROM THOMAS A. EDISON]

Indications de service.

V Brest

Le port est gratuit.
Le facteur doit remettre un récépissé à souche lorsqu'il est chargé de recouvrer une taxe

Télégramme.

Batchelor Paris

le

L'État n'est soumis à aucune responsabilité à raison du service de la correspondance privée par la voie télégraphique. (Loi du 29 novembre 1850, art. 6.)

N°

Timbre à date.

Pour de Newyork N° 79 Mots 12 Dépôt le à h. m. du

Dont tell London company anything about lamp manufacture

Ekmoride

rue du Parc N° 5 Ivry

Jarin 1871. — Malle n° 111 bis.

CABLE ADDRESS—EDISON, NEW YORK.

THOMAS A. EDISON,
No. 65 FIFTH AVENUE.

NEW YORK 29th Oct 1882

Mr Dear Batchelor

Your letter of 14th inst came to hand yesterday and in reply I would state that I do intend to furnish apparatus to England; & that I do not wish you to bid for the work. Of course if the English Company wish to manufacture they can do so but I think I shall always be able to supply them from here much cheaper. I have written to the Indian & Colonial Co on the subject.

Your cable about Cunnington Engines came to hand yesterday. I shall doubtless be able to give you a definite answer by Wednesday next.

I am sorry you got another shipment of tubes marked "Electric Lamps". We were too late to get the alteration made in the B/L. It will not occur again however.

Yours truly

Thos A. Edison

[ca. 1882-1883]

Rawitt, W.F.

Oct-12.

My dear Sir,

Will you please tell me if there is any chance of my obtaining some illustrations of Edison's work at Electric Lighting for my lectures at Birmingham Nov 7. 14.

I shd like to show that duplicate frame you have of the process

of manufacturing the carbon filaments that would be most interesting, and also the inventor of the lamp, the meter & everything else you think suitable.

I am writing to Colonel Gouraud & am sorry I missed seeing him in London.

What about that Pond Indicator, Mr Mackenzie borrowed the notice in the Times which I lent him & has not returned it. I should be glad to share the Indicator also if one is to be had.

I send you a couple of my Edison lectures and can share you two other more if you wish they are nearly out of print now.

How does the large machine work, or is it yet at

work?

I shall be very grateful for any particulars you can send me of the details of your lamps: such as horse power, cost, no. of volts required to give 16 candles, resistance &c. &c. I will have diagrams made & show the whole thing fully. The audience is a very large & influential one & I am anxious both the thing well

Yours sincerely

W. F. Barrett

[ca. 1882-1883]

Oct 28.

Dear Mr Batchelor,

Did you get my letter, Colonel Gouraud has kindly sent me some lamps, but I want to show a specimen of your meter & manufacture of the carbons, & gas brackets.

I am having large diagrams made to show these. If Mr Johnson

W. F. Barrett

Can let me have them well & good, Nov 12. Midland Institute, Birmingham.

Has your photometric assistant got Everett's book of units yet, I asked a friend to take him a copy to Paris but don't know if it reached him. If it did not I will post him a copy, if he wishes.

How many patents & provisional protections, - has Edison taken out, Can you tell me for I want to tell the public here. Yours sincerely

W. F. Barrett

What a good article the Daily News gave you, & I am

glad to see Edison got the
highest honour of the exhibition

[ca. 1882-1883] [FROM JAMES EDWARD HENRY GORDON]

of a size for a full
page plate in my book
the book to be
i.e. 7 inches by 4 inches
We would engrave it
in England - also we
should be glad of
small drawings of any
of the parts -
I should like all the
principal dimensions
marked on it
We would of course pay the
expense incurred
If you are able to give
us electro's of really
good blocks of it and

Oct 27

9, CLARENDON ROAD,
SOUTH KENSINGTON.W.

My dear Sir
I am now preparing
a new edition of my
"Electricity" and am
anxious to give an
account of the great Edison
machine with a good
picture -
Would it be giving you
too much trouble if I
were to ask you to
kindly have a perspective drawing
prepared of it for me

3

to save us expiring new
ones so much the better
an early reply will
oblige
Yours very
J E Hforden

[ca. 1882-1884]

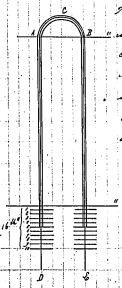
Mesurements

showing the shrinkage of fibres after carbonisation

These mesurements have been made with a thousendth-gage. The fibres 6" and 6½" have been mesured on three places, those of 8" and 9" on five places, and for each fibre the average was taken after these different mesurements.

The carbons have been mesured the same with a thousendth-gage on two (6", 6½") or four (8", 9") places and the average was taken for each carbon.

As for the length of the carbons it has been mesured by tracing a carbon on the paper as shown by the sketch.



The half-circle A B C was calculated and the parts A D and B E divided in inches. The length of the carbon was red immediately from the scale.

For those carbons which had not the right shape and could not be mesured that way always the average was taken.

Mesurements have been made on

fibres:

100	8×13.5	6½"
120	8×15.5	6"
120	13×32	8"
120	8×17	6"
200	12×70	9"

and the corresponding carbons, and gave following results:

100 fibres 8×13·4 6½" 16 candles.

1.	8×13·4 6½"	21.	8×13·6 6½"	41.	8×13·5 6½"	61.	8·2×13·5 6½"	81.	8×14 6½"		
2.	8×13·5 "	22.	8×13·9 "	42.	8×14 "	62.	8·2×13·5 "	82.	8×13·2 "	1-20	160·2 × 270
3.	8×13·6 "	23.	8×13·8 "	43.	8×13·7 "	63.	8·2×13·5 "	83.	8×13·4 "	21-40	160·5 × 273·2
4.	8×13·6 "	24.	8×13·9 "	44.	8×13·8 "	64.	7·5×13·5 "	84.	8×13·5 "	41-60	160·6 × 272
5.	8×13·5 "	25.	8×13·8 "	45.	8×13·8 "	65.	8×14 "	85.	8·2×13·8 "	61-80	161 × 271·4
6.	8×14 "	26.	8×13·5 "	46.	8×13·8 "	66.	8×13·8 "	86.	8×13·5 "	81-100	161·1 × 271·6
7.	8×13·5 "	27.	8×13·7 "	47.	8×13·7 "	67.	8×13·5 "	87.	8×13·5 "		803·4 × 1358·2
8.	8·2×13·4 "	28.	8×13·5 "	48.	8·4×13·5 "	68.	8×13 "	88.	8×13·5 "		803·4 : 100 = 8·034
9.	8×13 "	29.	8×14 "	49.	7·8×13·5 "	69.	8×14 "	89.	8×13·5 "		1358·2 : 100 = 13·582
10.	8×13·5 "	30.	8×14 "	50.	8×13·5 "	70.	8×13·5 "	90.	8×13·2 "		
11.	8×13·6 "	31.	8×13·5 "	51.	8·5×13·9 "	71.	7·6×14 "	91.	8×13·8 "		
12.	8×13 "	32.	8·2×13·5 "	52.	8·2×13·5 "	72.	8×13·8 "	92.	8×14 "		
13.	8×13·5 "	33.	8·5×13·5 "	53.	8×13·5 "	73.	8·5×13·5 "	93.	8×13·5 "		
14.	8×13·5 "	34.	8×13·6 "	54.	8×13·2 "	74.	8×13·5 "	94.	8×13·5 "		
15.	8×13·5 "	35.	8×13·8 "	55.	8×13·5 "	75.	8·2×13·5 "	95.	8×13·8 "		
16.	8×13·6 "	36.	7·8×13·2 "	56.	8×13·5 "	76.	8×13·9 "	96.	8×13·5 "		
17.	8×13·7 "	37.	8×13·5 "	57.	7·5×13·5 "	77.	8·2×13·5 "	97.	8·2×13·8 "		
18.	8×13·5 "	38.	8×13·6 "	58.	8×13·5 "	78.	8×13·2 "	98.	8×13·5 "		
19.	8×13·6 "	39.	8×13·5 "	59.	8×13·6 "	79.	8·2×13·2 "	99.	8·2×13·6 "		
20.	8×13·5 "	40.	8×13·8 "	60.	8·2×14 "	80.	8·2×13·5 "	100.	8·5×13·5 "		
1-20	160·2 × 270 "	21-40	160·5 × 273·2 "	41-60	160·6 × 272	61-80	161 × 271·4	81-100	161·1 × 271·6		

The average is: 8·034 × 13·582 × 6½"

result.

The fibres should be throughout 8×13·5, the average being 8·034 × 13·582.

The difference is in { thickness + 0·034 / width + 0·082 }

In percent of the normal dimensions { thickness + 0·425 % / width + 0·607 % }

These 100 fibres gave following carbons:

100 carbons 0.2 × 15.5 cm 64° 16 candles

1.	5.7×15.5	5¾	11.	5.9	5¾	21.	5.7×15.5	5¾	31.	5.7×15.5	5¾
2.	5.7×9	"	12.	5.7×9	"	22.	5.7×9	"	32.	5.7	"
3.	5.9	5¾	13.	5.7×9	"	23.	5.7×15	"	33.	5.7	"
4.	5.7×15	"	14.	5.7×9	"	24.	5.7×15.5	"	34.	5.7×15.5	"
5.	5.7×15	5¾	15.	5.7×9	"	25.	5.7×15.5	"	35.	5.7×15.5	5¾
6.	5.7×15.5	"	16.	5.9	5¾	26.	5.7×9	"	36.	5.7×15.5	"
7.	5.7×15.5	"	17.	5.7×15	5¾	27.	5.9	"	37.	5.7×15.5	"
8.	5.7×15.5	"	18.	5.7	"	28.	5.7×15	"	38.	5.7×9	"
9.	5.7×15	"	19.	5.9	"	29.	5.7×9	"	39.	5.7×15.5	"
10.	5.9	"	20.	5.9	"	30.	5.9	"	40.	5.7×15.5	"
11.	5.7	"	21.	5.7×15	"	31.	5.7×15	"	41.	5.7×15.5	"
12.	5.7×15.5	"	22.	5.7×15.5	"	32.	5.9	"	42.	5.7×15.5	"
13.	5.9	"	23.	5.7×9	"	33.	5.7×15.5	5¾	43.	5.7×15.5	"
14.	5.7×15.5	5¾	24.	5.7×15	"	34.	5.7×15	"	44.	5.7×15	"
15.	5.7×15.5	"	25.	5.7×9	5¾	35.	5.7×9	"	45.	5.7×15	"
16.	5.9	5¾	26.	5.9	"	36.	5.7×15.5	"	46.	5.9	"
17.	5.9	"	27.	5.7×15.5	"	37.	5.9	"	47.	5.7×15.5	"
18.	5.7×15.5	"	28.	5.7×9	"	38.	5.7×9	"	48.	5.9	"
19.	5.7×15.5	5¾	29.	5.9	"	39.	5.9	"	49.	5.9	"
20.	5.7×15.5	"	30.	5.7×9	"	40.	5.7×15.5	"	50.	5.9	"
	1.5×1.7×15.5			1.5×1.7×15			1.5×1.7×15			1.5×1.7×15	

The average is: 1.5 × 1.7 × 15.5 × 5¾"

result The shrinkage is in { length 1¾" / thickness 0.026 / width 4.932 } thousandth "

In percents of the normal dimensions: { length 21.15 % / thickness 27.455 % / width 36.31 % }

120 fibres 0.2 × 15.5 × 6° 16 candles

1.	0.2×15.5	6°	21.	0.2×15	6°	41.	0.2×15	6°	61.	0.2×15.5	6°
2.	0.2×15.5	"	22.	0.2×15	"	42.	0.2×15.5	"	62.	0.2×15.5	"
3.	0.2×15	"	23.	0.2×15	"	43.	0.2×15.5	"	63.	0.2×15.5	"
4.	0.2×15.5	"	24.	0.2×15	"	44.	0.2×15	"	64.	0.2×15.5	"
5.	0.2×15.5	"	25.	0.2×15	"	45.	0.2×15	"	65.	0.2×15.5	"
6.	0.2×15.5	"	26.	0.2×15	"	46.	0.2×15.5	"	66.	0.2×15.5	"
7.	0.2×15.5	"	27.	0.2×15	"	47.	0.2×15	"	67.	0.2×15.5	"
8.	0.2×15.5	"	28.	0.2×15	"	48.	0.2×15	"	68.	0.2×15	"
9.	0.2×15.5	"	29.	0.2×15	"	49.	0.2×15	"	69.	0.2×15	"
10.	0.2×15.5	"	30.	0.2×15	"	50.	0.2×15.5	"	70.	0.2×15	"
11.	0.2×15.5	"	31.	0.2×15.5	"	51.	0.2×15	"	71.	0.2×15	"
12.	0.2×15	"	32.	0.2×15.5	"	52.	0.2×15.5	"	72.	0.2×15	"
13.	0.2×15.5	"	33.	0.2×15.5	"	53.	0.2×15	"	73.	0.2×15	"
14.	0.2×15.5	"	34.	0.2×15.5	"	54.	0.2×15.5	"	74.	0.2×15	"
15.	0.2×15.5	"	35.	0.2×15.5	"	55.	0.2×15	"	75.	0.2×15	"
16.	0.2×15.5	"	36.	0.2×15.5	"	56.	0.2×15.5	"	76.	0.2×15.5	"
17.	0.2×15.5	"	37.	0.2×15.5	"	57.	0.2×15	"	77.	0.2×15	"
18.	0.2×15.5	"	38.	0.2×15.5	"	58.	0.2×15.5	"	78.	0.2×15	"
19.	0.2×15	"	39.	0.2×15	"	59.	0.2×15.5	"	79.	0.2×15	"
20.	0.2×15.5	"	40.	0.2×15.5	"	60.	0.2×15.5	"	80.	0.2×15.5	"
21.	0.2×15.5	"	41.	0.2×15.5	"	61.	0.2×15	"	81.	0.2×15	"
22.	0.2×15.5	"	42.	0.2×15.5	"	62.	0.2×15	"	82.	0.2×15	"
23.	0.2×15.5	"	43.	0.2×15.5	"	63.	0.2×15.5	"	83.	0.2×15	"
24.	0.2×15.5	"	44.	0.2×15	"	64.	0.2×15.5	"	84.	0.2×15	"
25.	0.2×15.5	"	45.	0.2×15.5	"	65.	0.2×15.5	"	85.	0.2×15.5	"
26.	0.2×15.5	"	46.	0.2×15.5	"	66.	0.2×15.5	"	86.	0.2×15.5	"
27.	0.2×15.5	"	47.	0.2×15.5	"	67.	0.2×15.5	"	87.	0.2×15.5	"
28.	0.2×15.5	"	48.	0.2×15.5	"	68.	0.2×15.5	"	88.	0.2×15.5	"
29.	0.2×15.5	"	49.	0.2×15.5	"	69.	0.2×15.5	"	89.	0.2×15.5	"
30.	0.2×15.5	"	50.	0.2×15.5	"	70.	0.2×15.5	"	90.	0.2×15.5	"
31.	0.2×15.5	"	51.	0.2×15.5	"	71.	0.2×15.5	"	91.	0.2×15.5	"
32.	0.2×15.5	"	52.	0.2×15.5	"	72.	0.2×15.5	"	92.	0.2×15.5	"
33.	0.2×15.5	"	53.	0.2×15.5	"	73.	0.2×15.5	"	93.	0.2×15.5	"
34.	0.2×15.5	"	54.	0.2×15.5	"	74.	0.2×15.5	"	94.	0.2×15.5	"
35.	0.2×15.5	"	55.	0.2×15.5	"	75.	0.2×15.5	"	95.	0.2×15.5	"
36.	0.2×15.5	"	56.	0.2×15.5	"	76.	0.2×15.5	"	96.	0.2×15.5	"
37.	0.2×15.5	"	57.	0.2×15.5	"	77.	0.2×15.5	"	97.	0.2×15.5	"
38.	0.2×15.5	"	58.	0.2×15.5	"	78.	0.2×15.5	"	98.	0.2×15.5	"
39.	0.2×15.5	"	59.	0.2×15.5	"	79.	0.2×15.5	"	99.	0.2×15.5	"
40.	0.2×15.5	"	60.	0.2×15.5	"	80.	0.2×15.5	"	100.	0.2×15.5	"
	191.2 × 3.9852			191.2 × 3.9824			191.2 × 3.9787			190.2 × 3.9787	

The average is: 191.2 × 3.97 × 15.5 × 6°

result The fibres should be 0.2 × 15.5, the average is 3.97 × 14.197; therefore the difference in { thickness −0.03 / width +0.697 } In percents of the normal dimensions { thickness −0.15 % / width +5.15 % }

These 120 fibres gave carbons of following dimensions:

120 carbons 5 x 13.5 6" 16 candles

1.	5 x 8 4 11/16"	25.	6 x 9 4 11/16"	49.	5.5 x 9 4 11/16"	73.	5.5 x 8 4 11/16"	97.	5.5 x 9 4 11/16"
2.	5.5 x 9 "	26.	6 x 9.5 "	50.	6 x 9 "	74.	5.5 x 9 "	98.	5.5 x 9.5 "
3.	5 x 8.5 "	27.	6 x 9 "	51.	5 x 8 "	75.	5.5 x 8.5 "	99.	5.5 x 10 "
4.	5.5 x 9.5 "	28.	5 x 8 "	52.	5.5 x 9.5 "	76.	5 x 8 "	100.	5.5 x 8.5 "
5.	5.5 x 8.5 "	29.	5.5 x 9 "	53.	5.5 x 9.5 "	77.	6 x 9.5 "	101.	5.5 x 8.5 "
6.	6 x 8.5 4 12/16"	30.	6 x 9.5 "	54.	5 x 8 "	78.	5 x 9 "	102.	5 x 8 "
7.	5.5 x 9 "	31.	5.5 x 8.5 "	55.	5 x 8.5 "	79.	5 x 8.5 "	103.	5.5 x 8 "
8.	5 x 8.5 "	32.	6 x 8.5 "	56.	5.5 x 9.5 "	80.	5.5 x 9 "	104.	5 x 8.5 "
9.	6 x 8.5 4 11/16"	33.	5 x 8 "	57.	5.5 x 9 "	81.	5.5 x 8.5 "	105.	5.5 x 8 "
10.	5.5 x 8.5 "	34.	5 x 9.5 "	58.	5.5 x 9 "	82.	5 x 9 "	106.	5.5 x 9.5 "
11.	5 x 8 4 12/16"	35.	5.5 x 9 "	59.	5 x 8 "	83.	5 x 8 "	107.	6 x 8.5 "
12.	5 x 8 4 10/16"	36.	5.5 x 9 "	60.	5.5 x 9.5 "	84.	5.5 x 8 "	108.	5.5 x 8.5 "
13.	6 x 9 "	37.	6 x 10 "	61.	5.5 x 8.5 "	85.	5.5 x 8.5 "	109.	5.5 x 9 "
14.	5.5 x 9 4 11/16"	38.	5.5 x 8 "	62.	5.5 x 8 "	86.	5.5 x 9 "	110.	6 x 9 "
15.	5.5 x 9 "	39.	5.5 x 9.5 "	63.	5 x 8 "	87.	5.5 x 8 "	111.	5.5 x 9 "
16.	6 x 10 "	40.	5 x 8.5 "	64.	5.5 x 8 "	88.	6 x 9 "	112.	5.5 x 8.5 "
17.	5.5 x 8.5 "	41.	5.5 x 9.5 "	65.	5.5 x 8 "	89.	5.5 x 8.5 "	113.	5.5 x 9 "
18.	6 x 10 "	42.	5 x 8 "	66.	5 x 8 "	90.	5 x 8 "	114.	5.5 x 8 "
19.	5.5 x 8 "	43.	5 x 9 "	67.	5 x 8.5 "	91.	6 x 10 "	115.	5.5 x 8 "
20.	5.5 x 8.5 "	44.	5.5 x 9 "	68.	5 x 8.5 "	92.	6 x 9.5 "	116.	5 x 8 "
21.	5.5 x 9 "	45.	6 x 9 "	69.	5.5 x 9 "	93.	5.5 x 8 "	117.	5 x 8 "
22.	5.5 x 9 "	46.	5 x 8 "	70.	5.5 x 9 "	94.	5.5 x 9 "	118.	5.5 x 9 "
23.	5.5 x 10 "	47.	5.5 x 8.5 "	71.	6 x 9.5 "	95.	5.5 x 8 "	119.	5 x 8.5 "
24.	5.5 x 9 "	48.	6 x 9 "	72.	5.5 x 9 "	96.	5.5 x 8.5 "	120.	5.5 x 9 "
1-24	132 x 211.5	25-48	132.5 x 212.5	49-72	129 x 208.5	73-96	131 x 207	97-120	130.5 x 207.5

1-24 132 x 211.5
25-48 132.5 x 212.5
49-72 129 x 208.5
73-96 131 x 207
97-120 130.5 x 207.5

655 x 1047

655 : 120 = 5.458
550
700
1000

1047 : 120 = 8.725
870
300
600

The average is: 5.458 x 8.725 x 4 11/16"

result. The shrinkage is in { length 1 5/16" ; thickness 2.512 ; width 5.472 } thousandth "

In percents of the normal dimensions { length 21.87 % ; thickness 31.4 % ; width 40.53 % }

120 fibres 13 x 32 8" 50 candles

1.	13 x 32 8"	25.	13 x 32.4 8"	49.	13 x 32 8"	73.	13 x 32.5 8"	97.	13 x 32 8"
2.	13 x 32.2 "	26.	13 x 32.2 "	50.	13 x 32.5 "	74.	12.5 x 31.8 "	98.	13 x 32 "
3.	13 x 32.2 "	27.	12.5 x 32.5 "	51.	13 x 32 "	75.	13 x 32 "	99.	12.8 x 32.5 "
4.	13 x 32.4 "	28.	13 x 33 "	52.	13 x 32 "	76.	13 x 32 "	100.	13 x 32 "
5.	13 x 32.2 "	29.	13 x 32 "	53.	13 x 32.5 "	77.	12.5 x 32.5 "	101.	12.5 x 32.5 "
6.	13 x 32 "	30.	13 x 32 "	54.	13 x 32 "	78.	12.5 x 32 "	102.	13 x 33 "
7.	13 x 32 "	31.	13.2 x 32.5 "	55.	13 x 32.5 "	79.	13 x 32.2 "	103.	13 x 32.5 "
8.	13 x 32.2 "	32.	13 x 32.5 "	56.	13 x 32 "	80.	13 x 32 "	104.	13 x 31.8 "
9.	13 x 32.5 "	33.	13 x 33 "	57.	13 x 32.5 "	81.	13 x 32.5 "	105.	13 x 32.5 "
10.	13 x 32.5 "	34.	13 x 32.5 "	58.	13 x 32 "	82.	13 x 32.5 "	106.	13 x 32 "
11.	13 x 32.4 "	35.	13 x 32.5 "	59.	12.5 x 32 "	83.	12.5 x 32.5 "	107.	13 x 32.8 "
12.	13 x 32 "	36.	13 x 32.5 "	60.	13 x 32.5 "	84.	13 x 32 "	108.	13 x 32.5 "
13.	13 x 32.2 "	37.	13 x 32.5 "	61.	13.5 x 32.5 "	85.	13 x 32.5 "	109.	13 x 32.5 "
14.	12.5 x 32.5 "	38.	13 x 32.5 "	62.	13 x 32.5 "	86.	13 x 31.8 "	110.	13 x 32.5 "
15.	13 x 32 "	39.	13 x 33 "	63.	13 x 32 "	87.	13 x 32 "	111.	12.5 x 32.5 "
16.	13 x 32 "	40.	13 x 33 "	64.	13 x 32 "	88.	13 x 31.5 "	112.	13 x 32.5 "
17.	13 x 32.5 "	41.	13 x 32.2 "	65.	13 x 32.5 "	89.	13 x 32 "	113.	13 x 32.5 "
18.	13 x 32.5 "	42.	13 x 32 "	66.	13 x 32.5 "	90.	13 x 32 "	114.	13 x 32 "
19.	13 x 32.8 "	43.	13 x 32.5 "	67.	13.2 x 32.5 "	91.	12.5 x 32 "	115.	12.5 x 32 "
20.	13 x 32.5 "	44.	13 x 32.2 "	68.	12.5 x 32 "	92.	13 x 32.5 "	116.	13 x 32 "
21.	13 x 32.5 "	45.	13 x 32 "	69.	13.2 x 32.5 "	93.	12.5 x 32.5 "	117.	13 x 32.5 "
22.	13 x 32 "	46.	13 x 32 "	70.	13.5 x 33 "	94.	13 x 32.5 "	118.	13 x 32.2 "
23.	13 x 32.2 "	47.	13 x 32.5 "	71.	13.5 x 32.5 "	95.	13 x 32.5 "	119.	13 x 32 "
24.	13 x 32.2 "	48.	13 x 32 "	72.	13 x 32.5 "	96.	13 x 32 "	120.	13 x 32.5 "
1-24	311.5 x 774.5	25-48	311.7 x 778	49-72	312.9 x 775.5	73-96	309 x 772.3	97-120	310.3 x 775.8

1-24 311.5 x 774.5
25-48 311.7 x 778
49-72 312.9 x 775.5
73-96 309 x 772.3
97-120 310.3 x 775.8

1555.4 x 3876.1

1555.4 : 120 = 12.96
355
1154
740

3876.1 : 120 = 32.3
276
361

The average is: 12.96 x 32.3 x 8"

result. The dimensions should be 13 x 32, the average numbers are 12.96 x 32.3; therefore the difference in { thickness − 0.04 ; width + 0.3 } this makes in percents of normal dimensions { thickness − 0.3 % ; width + 0.938 % }

These 120 fibres gave following carbons:

120 Carbons 11 x 32 8° 50 candles

1.	9 x 21·5	6 1/16"	27.	9 x 21	6 1/16"	53.	9 x 21·5	6 1/16"	79.	10 x 21·5	6 1/16"	105.	9 x 21·5	6 1/16"			
2.	9·5 x 19·5	"	28.	10 x 22	"	54.	9 x 21·5	"	80.	9 x 21·5	"	106.	9 x 20	"	132.	11·5 x 220 x 4·75	
3.	9 x 21·5	6 1/16"	29.	9 x 21·5	"	55.	9 x 21·5	"	81.	9 x 21·5	"	107.	9·5 x 20	"	133.	11·5 x 220·5 x 4·75	
4.	9 x 21	"	30.	9 x 21·5	"	56.	9 x 20	"	82.	9 x 21·5	"	108.	9·5 x 20·5	"	134.	11·5 x 220 x 4·75	
5.	9 x 21	"	31.	9 x 21	"	57.	9 x 21·5	"	83.	9 x 21·5	"	109.	9 x 21	"	135.	11·5 x 219 x 4·75	
6.	9 x 21·5	"	32.	9 x 21·5	"	58.	9 x 20	"	84.	9 x 21	"	110.	9·5 x 22	"	136.	11·5 x 222·5 x 4·75	
7.	9 x 21	"	33.	9 x 20	6 1/16"	59.	10 x 21·5	"	85.	10 x 21·5	"	111.	9 x 20	6 1/16"		11·02 x 218·5	
8.	9 x 21·5	"	34.	9 x 20·5	6 1/16"	60.	9 x 21·5	"	86.	9 x 21·5	6 1/16"	112.	9 x 20·5	6 1/16"		11·02 : 160 = 0·918 ·220 1010	
9.	9 x 21·5	"	35.	9 x 21	"	61.	9 x 21·5	6 1/16"	87.	9 x 21·5	6 1/16"	113.	9 x 21·5	6 1/16"			
10.	10 x 21·5	"	36.	9 x 20	"	62.	9 x 21	"	88.	9 x 21·5	"	114.	9 x 21·5	"		218·5 : 160 = 2·0375 ·160 ·585 ·525	
11.	10 x 21·5	"	37.	10 x 21	"	63.	9 x 20	6 1/16"	89.	9 x 20	"	115.	9 x 19	6 1/16"			
12.	9 x 20	"	38.	9 x 21·5	"	64.	9 x 21	6 1/16"	90.	9 x 20	"	116.	9 x 20	6 1/16"			
13.	9 x 21·5	6 1/16"	39.	9 x 20	"	65.	9 x 20	"	91.	9 x 21	"	117.	9 x 21	6 1/16"			
14.	10 x 21	6 1/16"	40.	9 x 21·5	"	66.	9 x 21·5	"	92.	9 x 20	"	118.	9 x 20	"			
15.	9 x 21	"	41.	9 x 20	"	67.	9 x 21·5	"	93.	9 x 21·5	"	119.	9 x 20·5	"			
16.	9 x 20	"	42.	9 x 21	"	68.	9 x 21·5	"	94.	9 x 21	"	120.	9 x 21·5	"			
17.	10 x 20	"	43.	9 x 21	"	69.	9 x 20	"	95.	9 x 21	"	121.	9 x 21	"			
18.	9 x 20·5	"	44.	9 x 21·5	"	70.	9 x 21·5	"	96.	9 x 21·5	"	122.	9 x 20	"			
19.	9 x 21	6 1/16"	45.	9 x 21·5	"	71.	9 x 21·5	"	97.	9 x 21	"	123.	9 x 20·5	"			
20.	9 x 21	"	46.	9 x 21	"	72.	9 x 21·5	"	98.	9 x 21·5	"	124.	9 x 21	"			
21.	9 x 21	"	47.	9 x 21·5	"	73.	9 x 21·5	"	99.	9 x 21·5	"	125.	9 x 21·5	"			
22.	9 x 21	"	48.	9 x 20	"	74.	9 x 21·5	"	100.	9 x 21	"	126.	9 x 20	"			
23.	9 x 21	"	49.	9 x 20	"	75.	10 x 22	"	101.	9 x 21	"	127.	9 x 20	"			
24.	9 x 21	"	50.	9 x 20	"	76.	9 x 21	"	102.	9 x 21	"	128.	9 x 20	"			
25.	9 x 21	"	51.	9 x 20	"	77.	9 x 21·5	"	103.	9 x 21	"	129.	9 x 20	"			
26.	9 x 21	"	52.	9 x 20	"	78.	10 x 22	"	104.	9 x 21	"	130.	9 x 20	"			
	220 x 4·75			220 x 4·75			219 x 4·75			222·5 x 4·75			218·5 x 4·75				

The average is:
9·14 x 20·72 x 6 1/16"

Results. The shrinkage is in { length 1·78 %, breadth 1·18 %, width 1·17 %

In percent of the normal dimensions { length 22·66 %, thickness 29·00 %, width 38·19 %

120 Lebes 9 x 17 6° 16 candles

1.	9 x 17·5	6	27.	9 x 17·5	6	53.	9 x 17·5	6	79.	9 x 17	6	105.	9 x 17	6			
2.	9 x 17·5	"	28.	9 x 17	"	54.	9 x 17·5	"	80.	9 x 17·5	"	106.	9 x 17	"	132.	11·5 x 410 x 4·75	
3.	9 x 17·5	"	29.	9 x 16·5	"	55.	9 x 17·5	"	81.	9 x 17·5	"	107.	9 x 17	"	133.	11·5 x 410·5 x 4·75	
4.	9 x 17·5	"	30.	9 x 17·5	"	56.	9 x 17·5	"	82.	9 x 17·5	"	108.	9 x 16·5	"	134.	11·5 x 410·5 x 4·75	
5.	9 x 17·5	"	31.	9 x 17	"	57.	9 x 17·5	"	83.	9 x 17·5	"	109.	9 x 17	"	135.	11·5 x 410 x 4·75	
6.	9 x 17	"	32.	9 x 17·5	"	58.	9 x 17·5	"	84.	9 x 17·5	"	110.	9 x 17	"	136.	11·5 x 411 x 4·75	
7.	9 x 17·5	"	33.	9 x 17·5	"	59.	9 x 17·5	"	85.	9 x 17·5	"	111.	9 x 17	"		9·02 x 206·9	
8.	9 x 17·5	"	34.	9 x 17·5	"	60.	9 x 17·5	"	86.	9 x 17·5	"	112.	9 x 17	"		9·02 : 160 = 7·935 ·126 ·720 ·630	
9.	9 x 17·5	"	35.	9 x 17·5	"	61.	9 x 17·5	"	87.	9 x 17·5	"	113.	9 x 17	"			
10.	9 x 17·5	"	36.	9 x 17	"	62.	9 x 17·5	"	88.	9 x 17·5	"	114.	9 x 17·5	"		206·9 : 160 = 1·293·5 ·160 ·469 ·320 ·1490	
11.	9 x 16·5	"	37.	9 x 17·5	"	63.	9 x 17·5	"	89.	9 x 17·5	"	115.	9 x 17	"			
12.	9 x 17·5	"	38.	9 x 17·5	"	64.	9 x 17·5	"	90.	9 x 17·5	"	116.	9 x 17·5	"			
13.	9 x 17·5	"	39.	9 x 17·5	"	65.	9 x 17·5	"	91.	9 x 17·5	"	117.	9 x 17	"			
14.	9 x 17·5	"	40.	9 x 17	"	66.	9 x 17	"	92.	9 x 17·5	"	118.	9 x 17	"			
15.	9 x 17·5	"	41.	9 x 17·5	"	67.	9 x 17·5	"	93.	9 x 17·5	"	119.	9 x 17	"			
16.	9 x 17·5	"	42.	9 x 17·5	"	68.	9 x 17·5	"	94.	9 x 17·5	"	120.	9 x 17	"			
17.	9 x 17·5	"	43.	9 x 17·5	"	69.	9 x 17·5	"	95.	9 x 17·5	"	121.	9 x 17	"			
18.	9 x 17·5	"	44.	9 x 17·5	"	70.	9 x 17·5	"	96.	9 x 17·5	"	122.	9 x 17	"			
19.	9 x 17·5	"	45.	9 x 17·5	"	71.	9 x 17·5	"	97.	9 x 17·5	"	123.	9 x 17	"			
20.	9 x 17·5	"	46.	9 x 17	"	72.	9 x 17·5	"	98.	9 x 17·5	"	124.	9 x 17	"			
21.	9 x 17·5	"	47.	9 x 17	"	73.	9 x 17·5	"	99.	9 x 17·5	"	125.	9 x 17	"			
22.	9 x 17·5	"	48.	9 x 17·5	"	74.	9 x 17·5	"	100.	9 x 17·5	"	126.	9 x 17	"			
23.	9 x 17·5	"	49.	9 x 17	"	75.	9 x 17·5	"	101.	9 x 17·5	"	127.	9 x 17	"			
24.	9 x 17·5	"	50.	9 x 17	"	76.	9 x 17·5	"	102.	9 x 17·5	"	128.	9 x 17	"			
25.	9 x 17·5	"	51.	9 x 17	"	77.	9 x 17·5	"	103.	9 x 17·5	"	129.	9 x 17	"			
26.	9 x 17·5	"	52.	9 x 17·5	"	78.	9 x 17·5	"	104.	9 x 17·5	"	130.	9 x 17	"			
	410 x 4·75			410 x 4·75			410 x 4·75			410 x 4·75			410 x 4·75				

The average is:
7·935 x 17·25 x 6"

Results. The normal dimensions are 9 x 17, the average number being 7·935 x 17·25, the difference is in { thickness − 0·065, width + 0·25

In percent of the normal dimensions { thickness − 0·81 %, width + 1·47 %

These fibres gave following results:

420 carbons 2.1" 6" 16 candles.

1. 5.5×11 7¾"	21. 6.1×5.5 4¾"	41. 5.5×11 4¾"	61. 5.5×5.5 4¾"	81. 5.5×11 4¾"		
2. 5.5×11 "	22. 6.1×5 "	42. 5.5×10.5 "	62. 5×10 "	82. 6×11 "	m-m 154.5×270.5	
3. 5×11 "	23. 6.1×5 "	43. 5.5×10.5 "	63. 5.5×10.5 "	83. 6×10 "	m-m 137.5×274.5	
4. 5.5×11 "	24. 6×11 "	44. 5.5×10.5 "	64. 6×11 "	84. 5.5×10.5 "	m-m 139.5×267.5	
5. 5.5×10.5 "	25. 6×10.5 "	45. 6×10.5 "	65. 5.5×10.5 "	85. 5.5×11 "	m-m 139.5×267.5	
6. 5.5×11 "	26. 6×10.5 "	46. 5.5×10.5 "	66. 5.5×11 "	86. 5×10 "	m-m 141 × 255.5	
7. 6×11 "	27. 6×10.5 "	47. 5×10 "	67. 5.5×11 "	87. 5×10 "	6.6 × 13.02	
8. 5.5×10 "	28. 6×10.5 "	48. 5×10 "	68. 5×11 "	88. 5.5×10.5 "	6.6 : 100 = 5.5715	
9. 5.5×10.5 "	29. 5.5×11 "	49. 5.5×11 "	69. 5.5×11 "	89. 5.5×11 "	660	
10. 5×10.5 "	30. 5.5×11 "	50. 5×10 "	70. 5×10 "	90. 5.5×10.5 "	557	
11. 5.5×11 "	31. 5.5×10.5 "	51. 5.5×10.5 "	71. 5.5×10.5 "	91. 5.5×10.5 "	100	
12. 5.5×11 "	32. 5.5×11 "	52. 5.5×11 "	72. 6×10.5 "	92. 5.5×10.5 "	1302 : 100 = 10.85	
13. 6×10.5 "	33. 5.5×10 "	53. 5.5×10.5 "	73. 5×10 "	93. 5.5×10.5 "	1200	
14. 5.5×11 "	34. 5.5×10.5 "	54. 5×10 "	74. 6×10.5 "	94. 5.5×10.5 "	100	
15. 5.5×11 "	35. 5.5×10.5 "	55. 5.5×10.5 "	75. 5×10 "	95. 5.5×10.5 "		
16. 6×10.5 "	36. 5×10 "	56. 5.5×10.5 "	76. 5×10.5 "	96. 5.5×10.5 "		
17. 6×10.5 "	37. 5.5×10 "	57. 5.5×10.5 "	77. 5.5×10.5 "	97. 5.5×10.5 "		
18. 5.5×11 "	38. 5×10 "	58. 5.5×11 "	78. 5×10 "	98. 5.5×10.5 "		
19. 5.5×10 "	39. 6×10 "	59. 5.5×10.5 "	79. 5×10 "	99. 5.5×10.5 "		
20. 5.5×10.5 "	40. 5.5×10.5 "	60. 5.5×11 "	80. 5.5×10.5 "	100. 5.5×10.5 "		
m-m 154.5×262.5	m-m 137.5×270	m-m 137.5×270.5	m-m 137.5×270.5	m-m 137.5×275.5		

The average is 5.5715 × 10.85 = 60.4

Result. The average is
in { length 1 ft
breadth 5.40
width 5.40 } Dim. ft"

In percents of the normal dimensions: { length 21.075 %
breadth 30.237 %
width 17.547 % }

200 fibers 12×70 0" 100 candles.

1. 12×70 9"	21. 12×70 9"	41. 12×70 9"	61. 12×70 9"	81. 11.5×69 9"		
2. 12×69 "	22. 12×70 "	42. 12×70 "	62. 12×70 "	82. 12×70 "	m-m 241 × 1897.5	
3. 12×70 "	23. 12×69.5 "	43. 11.5×70 "	63. 12×69.5 "	83. 12×70 "	m-m 239.5 × 1897.5	
4. 12×69.5 "	24. 12×70 "	44. 11.5×69.5 "	64. 11.5×70 "	84. 12×70 "	m-m 239 × 1895	
5. 12×70 "	25. 12×69 "	45. 11.5×70 "	65. 12×70 "	85. 12×70 "	m-m 239.5 × 1893	
6. 12×70 "	26. 12×70 "	46. 12×70 "	66. 11.5×70 "	86. 11.5×70 "	m-m 239.5 × 1895	
7. 12×70 "	27. 12×69.5 "	47. 12×70 "	67. 12×69.5 "	87. 12×70 "	11.96 × 69.25	
8. 12×70 "	28. 12×70 "	48. 12×70 "	68. 11.5×70 "	88. 11.5×70 "	11.96 : 100 = 11.965	
9. 12×69.5 "	29. 12×69.5 "	49. 11.5×70 "	69. 12×70 "	89. 12×70 "	69.25 : 100 = 69.775	
10. 12×70 "	30. 12×70 "	50. 12×69.5 "	70. 12×69.5 "	90. 12×69.5 "		
11. 12×70 "	31. 12×70 "	51. 12×70 "	71. 12×69.5 "	91. 12×69.5 "		
12. 12×70 "	32. 12×69.5 "	52. 12×70 "	72. 12×70 "	92. 12×70 "		
13. 12×70 "	33. 12×70 "	53. 12×70 "	73. 12×70 "	93. 12×70 "		
14. 12×69.5 "	34. 12×69.5 "	54. 12×70 "	74. 12×69.5 "	94. 12×69.5 "		
15. 12×70 "	35. 11.5×70 "	55. 12×70 "	75. 12×69.5 "	95. 12×70 "		
16. 12×69.5 "	36. 12×70 "	56. 12×70 "	76. 12×69.5 "	96. 12×70 "		
17. 12×70 "	37. 12×69.5 "	57. 12×70 "	77. 12×70 "	97. 12×70 "		
18. 12×70 "	38. 12×70 "	58. 12×70 "	78. 12×69.5 "	98. 12×69.5 "		
19. 12×70 "	39. 12×70 "	59. 12×70 "	79. 12×69 "	99. 12×70 "		
20. 12×69.5 "	40. 12×69.5 "	60. 12×70 "	80. 11.5×70 "	100. 11.5×69 "		
m-m 241×1897.5	m-m 239.5×1897.5	m-m 239 × 1895	m-m 239.5×1893	m-m 239.5×1895		

The average is 11.965 × 69.775

Result. The normal dimensions are 12×70, the average 11.965×69.775.
The difference is therefore in { thickness − 0.035
width − 0.225 }

In percents of the normal dimensions { thickness − 0.29 %
width − 0.32 %

These fibers gave 100 carbons of following dimensions:

200 carbons 12 x 70 100 candles

1.	9 x 44	6 7/16"	21.	8 5/8 x 43	6 5/16"	41.	10 x 43	6 3/16"	61.	8 5/8 x 42	6 3/16"												
2.	8 5/8 x 43	"	22.	9 x 43	"	42.	8 5/8 x 44 5/8	"	62.	9 x 42	"	82.	17 x 70	101.	12 x 70	9"	121.	12 x 70	9"	141.	12 x 70	9"	161.	12 x 69.5	9"		
3.	8 5/8 x 43 5/8	"	23.	8 5/8 x 43	"	43.	11 x 43	"	63.	8 5/8 x 41 5/8	"	83.	8 5/8 x 66.5	102.	12 x 70	"	122.	12 x 70	"	142.	11 5/8 x 69	"	162.	12 x 69.5	"	2nd no.	240 x 139.5
4.	8 5/8 x 42	"	24.	8 5/8 x 44 5/8	"	44.	9 x 44	"	64.	8 5/8 x 44	"	84.	8 5/8 x 44 5/8	103.	12 x 70	"	123.	12 x 69.5	"	143.	10 x 69.5	"	163.	12 x 69.5	"	4th no.	240 x 139.5
5.	8 5/8 x 42	"	25.	8 5/8 x 44 5/8	"	45.	9 x 44	"	65.	8 5/8 x 44	"	85.	8 5/8 x 44 5/8	104.	12 x 70	"	124.	12 x 69.5	"	144.	12 x 69.5	"	164.	12 x 69.5	"	6th no.	239.5 x 139.6
6.	8 5/8 x 44 5/8	"	26.	9 x 43	"	46.	9 x 44	"	66.	8 5/8 x 44	"	86.	8 5/8 x 44	105.	12 x 70	"	125.	12 x 69.5	"	145.	11 5/8 x 70	"	165.	12 x 69.5	"	8th no.	238 x 139.5
7.	9 x 44	"	27.	10 x 42	"	47.	9 x 43 5/8	"	67.	9 x 42	"	87.	8 5/8 x 41 5/8	106.	12 x 70	"	126.	12 x 69.5	"	146.	12 x 70	"	166.	12 x 69.5	"	10th no.	239.5 x 139.6
8.	8 x 45	"	28.	8 5/8 x 43	"	48.	9 x 42	"	68.	8 5/8 x 44	"	88.	8 5/8 x 44	107.	12 x 69.5	"	127.	12 x 69.5	"	147.	12 x 69.5	"	167.	12 x 69.5	"		
9.	8 5/8 x 45	"	29.	8 5/8 x 44	"	49.	9 x 42.5	"	69.	9 x 44	"	89.	8 5/8 x 44	108.	12 x 69.5	"	128.	12 x 69.5	"	148.	12 x 69.5	"	168.	12 x 70	"		
10.	8 5/8 x 42	"	30.	9 x 44 5/8	"	50.	8 5/8 x 43	"	70.	8 5/8 x 43	"	90.	8 5/8 x 44	109.	12 x 70	"	129.	12 x 69.5	"	149.	12 x 69.5	"	169.	12 x 70	"		
11.	8 5/8 x 44	"	31.	8 5/8 x 44	"	51.	8 5/8 x 42	"	71.	8 5/8 x 42	"	91.	8 5/8 x 42.5	110.	12 x 70	"	130.	12 x 70	"	150.	12 x 69.5	"	170.	12 x 69.5	"		
12.	8 5/8 x 42	"	32.	8 5/8 x 43	"	52.	9 x 43	"	72.	10 x 43	"	92.	10 x 43	111.	12 x 70	"	131.	12 x 69.5	"	151.	12 x 69.5	"	171.	11 5/8 x 69.5	"		
13.	8 5/8 x 44 5/8	"	33.	9 x 44 5/8	"	53.	8 5/8 x 44	"	73.	10 x 45	"	93.	9 x 43	112.	12 x 69.5	"	132.	12 x 69.5	"	152.	12 x 69.5	"	172.	12 x 69.5	"		
14.	8 5/8 x 44 5/8	"	34.	8 5/8 x 44	"	54.	8 5/8 x 44	"	74.	8 5/8 x 44	"	94.	8 5/8 x 44	113.	12 x 70	"	133.	12 x 69.5	"	153.	12 x 69.5	"	173.	12 x 70	"		
15.	10 x 45	"	35.	9 x 44	"	55.	8 5/8 x 43	"	75.	8 5/8 x 42	"	95.	8 5/8 x 44	114.	12 x 69.5	"	134.	12 x 69.5	"	154.	12 x 69.5	"	174.	12 x 69.5	"		
16.	8 x 44 5/8	"	36.	8 5/8 x 44	"	56.	8 5/8 x 43	"	76.	9 x 42	"	96.	9 x 42	115.	12 x 70	"	135.	12 x 69.5	"	155.	12 x 69.5	"	175.	12 x 70	"		
17.	9 x 45	"	37.	8 5/8 x 44 5/8	"	57.	8 5/8 x 43	"	77.	8 5/8 x 42	"	97.	8 5/8 x 44	116.	12 x 70	"	136.	12 x 69.5	"	156.	12 x 70	"	176.	11 5/8 x 69.5	"		
18.	10 x 44 5/8	"	38.	8 5/8 x 43	"	58.	8 5/8 x 42.5	"	78.	9 x 42	"	98.	8 5/8 x 42	117.	12 x 69.5	"	137.	12 x 69	"	157.	12 x 69.5	"	177.	12 x 69.5	"		
19.	8 x 43	"	39.	9 x 43	"	59.	8 5/8 x 44 5/8	"	79.	9 x 42	"	99.	10 x 43	118.	12 x 69.5	"	138.	12 x 69.5	"	158.	12 x 69.5	"	178.	12 x 69.5	"		
20.	8 5/8 x 44	"	40.	8 5/8 x 43 5/8	"	60.	8 5/8 x 43	"	80.	8 5/8 x 42.5	"	100.	8 5/8 x 42.5	119.	12 x 70	"	139.	12 x 69.5	"	159.	12 x 69.5	"	179.	12 x 70	"		
no.	174 x 870		no.	175 5/8 x 866.5		no.	180 7/8 x 876.5		no.	180 x 863		no.	180 x 867	no.	240 x 1395		no.	240 x 1395		no.	238 x 1393		no.	238.5 x 1394			

Average is: 8.7 x 43.45 = 378

Average is: 11.97 x 69.75 = 834.9

Average is: 11.97 x 69.75

result. The average is

in { length 2 7/16"
thickness 8.065
width 36.345

In Centimetres of the normal dimension { length 22.916 %
thickness 25.61 %
width 87.75 %

result. The dimension should be 12 x 70, the average is: 11.97 x 69.75, the difference is { thickness – 0.065
width – 0.25 }

In percents of the normal dimension { thickness – 0.2 %
width – 0.35 %

These fibres gave following 120 carbons:

200 carbons 12 x 70 100 candles.

101. 9.5 x 44.5 $6\frac{15}{16}$"	121. 9.5 x 46 $6\frac{15}{16}$"	141. 9.5 x 44 $6\frac{15}{16}$"	161. 8 x 43.5 $6\frac{15}{16}$"	181. 8 x 43 $6\frac{15}{16}$"	
102. 9 x 45 "	122. 8.5 x 43 "	142. 8.5 x 43.5 "	162. 8.5 x 41.5 "	182. 9 x 45 "	101-120 180 x 881
103. 10 x 44 "	123. 10 x 45 "	143. 9 x 44 "	163. 9 x 43.5 "	183. 8 x 44 "	121-140 182.5 x 877
104. 9.5 x 43.5 "	124. 9 x 42.5 "	144. 9.5 x 44 "	164. 8.5 x 45 "	184. 9.5 x 43.5 "	141-160 176 x 875.5
105. 9 x 44 "	125. 8.5 x 44 "	145. 8 x 43 "	165. 8.5 x 43 "	185. 9.5 x 44 "	161-180 175.5 x 873
106. 8.5 x 45.5 "	126. 9 x 43 "	146. 8.5 x 46 "	166. 9 x 46 "	186. 8 x 42 "	181-200 171 x 863.5
107. 9.5 x 44 "	127. 8.5 x 43.5 "	147. 9.5 x 44 "	167. 9 x 43 "	187. 8.5 x 42.5 "	885 x 4370
108. 9 x 43.5 "	128. 8 x 42.5 "	148. 9 x 43.5 "	168. 9 x 44 "	188. 8.5 x 43.5 "	885 : 100 = 8.85
109. 9 x 43 "	129. 9.5 x 44.5 "	149. 8 x 47 "	169. 8.5 x 43.5 "	189. 8.5 x 44 "	4370 : 100 = 43.7
110. 8 x 46.5 "	130. 9 x 45 "	150. 9 x 45 "	170. 9.5 x 46 "	190. 9 x 44 "	
111. 9 x 44 "	131. 9.5 x 42 "	151. 9 x 45 "	171. 9 x 42.5 "	191. 8 x 42 "	
112. 9.5 x 45 "	132. 9 x 44 "	152. 8.5 x 40 "	172. 9 x 43 "	192. 9.5 x 45 "	
113. 9 x 44 "	133. 9.5 x 44 "	153. 9 x 43 "	173. 8.5 x 44 "	193. 7.5 x 42 "	
114. 8.5 x 43 "	134. 10 x 43.5 "	154. 8.5 x 43.5 "	174. 8.5 x 45 "	194. 9 x 43.5 "	
115. 9.5 x 44 "	135. 10 x 46 "	155. 8.5 x 43.5 "	175. 8.5 x 43 "	195. 9 x 42 "	
116. 9.5 x 42 "	136. 8 x 43.5 "	156. 9 x 43.5 "	176. 9.5 x 45.5 "	196. 9 x 44 "	
117. 8.5 x 46 "	137. 9 x 43 "	157. 8 x 43.5 "	177. 8 x 43 "	197. 8 x 42.5 "	
118. 8.5 x 45.5 "	138. 9 x 43 "	158. 9 x 41.5 "	178. 9 x 44.5 "	198. 8 x 44 "	
119. 9.5 x 45 "	139. 9 x 45 "	159. 9 x 42 "	179. 9 x 42 "	199. 8 x 42.5 "	
120. 7.5 x 42 "	140. 10 x 44 "	160. 9 x 43 "	180. 9 x 43.5 "	200. 8.5 x 42.5 "	
101-120 180 x 881	121-140 182.5 x 877	141-160 176 x 875.5	161-180 175.5 x 873	181-200 171 x 863.5	

The average is: 8.85 x 43.7 x $6\frac{15}{16}$

result.

The shrinkage is:
- length $2\frac{1}{16}$"
- thickness 3.125
- width 26.055

In percents of the normal dimensions:
- length 22.916 %
- thickness 26.93 %
- width 37.35 %

General results.

Normal dimensions of fibres: length	thickness	width	Average dimensions of fibres: length	thickness	width	Difference between normal and average dim: length	thickness	width	Difference in percents of norm. dim: length	thickness	width	Dimensions of carbons: length	thickness	width	Shrinkage: length	thickness	width	Shrinkage in percents of norm. dim.: length	thickness	width	Shrinkage in percents of the average dimens.: length	thickness	width
[illegible]	8	15.5	$6\frac{1}{4}$"	8.034	15.582	0	+0.034	+0.082	0	0.425 %	0.607 %	$5\frac{3}{16}$"	6.108	8.65	$1\frac{1}{16}$"	2.026	4.932	21.15 %	27.458 %	36.31 %	21.15 %	27.34 %	36.09 %
6"	8	13.5	6"	7.97	14.197	0	−0.03	+0.597	0	0.375 %	+5.16 %	$4\frac{11}{16}$"	5.458	8.725	$1\frac{5}{16}$"	2.572	5.472	21.87 %	31.4 %	40.53 %	21.87 %	31.57 %	38.54 %
6"	8	17	6"	7.935	17.25	0	−0.065	+0.25	0	0.81 %	1.47 %	$4\frac{11}{16}$"	5.516	10.85	$1\frac{5}{16}$"	2.419	6.4	21.875 %	30.237 %	37.647 %	21.875 %	30.48 %	37.1 %
[illegible]	13	32	[illegible]	12.96	32.3	0	−0.04	+0.3	0	0.3 %	0.938 %	$6\frac{3}{16}$"	9.18	20.72	$1\frac{13}{16}$"	3.78	11.58	22.66 %	29.08 %	36.19 %	22.66 %	29.17 %	35.85 %
9"	12	70	9"	11.965	69.775	0	−0.035	−0.225	0	0.29 %	0.32 %	$6\frac{15}{16}$"	8.9	43.43	$2\frac{1}{16}$"	3.065	26.345	22.916 %	25.61 %	37.75 %	22.916 %	25.61 %	37.76 %
9"	12	70	9"	11.975	69.755	0	−0.025	−0.245	0	0.2 %	0.35 %	$6\frac{15}{16}$"	8.85	43.7	$2\frac{1}{16}$"	3.125	26.055	22.916 %	26.90 %	37.35 %	22.916 %	26.09 %	37.35 %

Average shrinkage in percents of the normal dimensions of fibres:
- length 22.231 %
- thickness 28.452 %
- width 37.629 %

Average shrinkage in percents of the average dimensions of fibres:
- length 22.231 %
- thickness 28.366 %
- width 37.115 %

Table for carbons of lamps.

	Carbons of Lamps	Dimensions of carbons: Length in"	Diameter in thousandth"	Width in thousandth"	Section in millimeters	Amperes per one million. radius	Proportion between the amperes per one millim. meter and the diameter	Surface in millimeters	Surface in millimeters	Luminous intensity per unit of surface (candles in millimeters)	Surface in millimeters per one candle	Proportion between the surface and the duration	Remarks
X	8×11.5 sec. 8 candles	1.0554	1.7324	0.1111	0.03			85.55	0.132	7.11			
X	8×11.5" 8 candles	0.3111	1.7324	0.1111	0.03			51.325	0.150	6.666			
X	8×11.5" 8 candles	0.3131	1.7324	0.1111	0.03			57.7647	0.138	7.223			
X	8×11.5" 8 candles	0.4112	1.7324	0.1111	0.03		X	116.65	0.137	7.29			
X	8×11.5" 8 candles	0.5115	1.7324	0.1111	0.03		X	115.5374	0.138	7.24			
X	8×7.5" 8 candles	0.3111	1.7324	0.1296	0.038			61.575	0.129	7.742			
X	8×7.5" 8 candles	0.3135	1.7324	0.1296	0.038			66.706	0.1133	8.838			
X	8×7.5" 8 candles	0.4112	1.7324	0.1296	0.038			123.15	0.1239	7.677			
X	8×7.5" 8 candles	0.5115	1.7324	0.1296	0.038			133.412	0.1139	8.772			
X	8×7.5" 16 candles	0.3115	0.8659	0.1164	0.117			65.562	0.152	6.55			
X	8×7.5" 16 candles	0.4112	0.8659	0.1164	0.117			78.6	0.127	7.86			
X	8×7.5" 16 candles	0.5112	0.8659	0.1296	0.093			162.3	0.137	5.07			
X	16×7.5" 16 candles	0.4112	0.8659	0.1296	0.112	X		158.8125	0.104	9.555			
X	16×7.5" 16 candles	0.5112	0.8659	0.1296	0.093			211.225	0.121	6.413			
X	16×7.5" 16 candles	0.4112	0.7559	0.1296	0.096			181.65	0.137	5.66			
X	16×7.5" 16 candles	0.5112	0.7559	0.1296	0.096			102.96	0.110	9.08			
X	8×12.5" 8 candles	0.4112	0.5118	0.1157	0.117			294.28	0.169	5.885			
X	16×12.5" 16 candles	0.5112	0.5118	0.1296	0.236			591.66	0.169	5.916			

120 fibres 8 x 17 6"

1.	8.2 x 17.4	21.	8 x 16.5	41.	7.5 x 16.8	61.	8 x 17.5
2.	8 x 17.5	22.	8 x 17.5	42.	8 x 17.2	62.	8 x 17.5
3.	8 x 17	23.	8 x 17	43.	8 x 17	63.	8 x 18
4.	8.2 x 17.2	24.	8 x 17	44.	8 x 17	64.	7.5 x 17
5.	8 x 17	25.	8 x 17.5	45.	8 x 17.6	65.	8 x 17
6.	8 x 17	26.	8 x 17	46.	8 x 18	66.	8 x 17.5
7.	7.5 x 17	27.	8 x 16.5	47.	8 x 17	67.	7.5 x 17.5
8.	8.2 x 17.5	28.	7.5 x 17.5	48.	8 x 17	68.	8 x 17
9.	8 x 17.5	29.	8 x 17.5	49.	8 x 17.5	69.	8 x 16.5
10.	8 x 17.2	30.	8 x 17	50.	7.5 x 17.5	70.	8.5 x 17.5
11.	8.2 x 16.8	31.	8 x 17.5	51.	8 x 17.5	71.	8 x 17
12.	8 x 17.5	32.	8 x 17.5	52.	8 x 17.5	72.	8 x 17.5
13.	8 x 17.5	33.	7.5 x 17.5	53.	8 x 17.2	73.	8 x 18
14.	8 x 17.5	34.	8 x 18	54.	8 x 17.5	74.	8 x 17
15.	7.5 x 17.5	35.	8 x 17	55.	7.5 x 18	75.	8 x 18
16.	8 x 17.5	36.	8 x 17	56.	7.5 x 17.6	76.	8 x 17.5
17.	7.5 x 17	37.	8 x 17.5	57.	8 x 17	77.	8 x 17.5
18.	7.5 x 17.5	38.	7.5 x 17	58.	8 x 17	78.	8 x 17.2
19.	8 x 17	39.	8 x 17.5	59.	8 x 17	79.	8 x 17
20.	8 x 17.2	40.	8 x 17	60.	8 x 17.5	80.	8 x 17.5
	159.7 x 345.2		158.8 x 345.8		158.9 x 345.5		159.1 x 347.2

81.	8 x 17.5	101.	7.5 x 17.5	159.7	345.7
82.	8 x 17.5	102.	7.5 x 18	158.8	345.8
83.	8 x 17	103.	8 x 17	158.9	345.7
84.	8 x 17.2	104.	8 x 17	159.1	347.2
85.	8 x 17	105.	8 x 17	159.3	343.4
86.	8 x 17.2	106.	8 x 16.8	156.4	342.8
87.	8 x 17.5	107.	7.5 x 17	952.2	2070.6
88.	8 x 17	108.	7.5 x 17		
89.	8 x 17	109.	7.5 x 17		
90.	8 x 17	110.	7.5 x 17		
91.	8 x 17.5	111.	7.5 x 17.5		
92.	8 x 17.2	112.	7.5 x 17.5		
93.	8 x 17	113.	7.5 x 17		
94.	7.5 x 17.5	114.	8 x 17		
95.	7.5 x 17.5	115.	8 x 17		
96.	8 x 17	116.	8 x 17.5		
97.	8 x 17	117.	7.5 x 17		
98.	8 x 17	118.	8 x 17		
99.	8 x 16.4	119.	7.5 x 17		
100.	8 x 17	120.	7.5 x 17		
	159.3 x 343.4		156.4 x 342.8		

952.2 : 20 = 7.935
1122
420
600
2070.6 : 120 = 17.255
870
306
660
660

Average 7.935 x 17.255

120 Timbers 13 x 32 ... 8"

1.	13 x 32	21.	13 x 32·5	41.	13 x 32·2	61.	13·5 x 32·5
2.	13 x 32·2	22.	13 x 32	42.	13 x 32	62.	13 x 32·5
3.	13 x 32·2	23.	13 x 32·2	43.	13 x 32·5	63.	13 x 32
4.	13 x 32·4	24.	13 x 32·2	44.	13 x 32·2	64.	13 x 32
5.	13 x 32·2	25.	13 x 32·4	45.	13 x 32	65.	13 x 32·5
6.	13 x 32	26.	13 x 32·2	46.	13 x 32	66.	13 x 32·5
7.	13 x 32	27.	12·5 x 32·5	47.	13 x 32·5	67.	13·2 x 32·5
8.	13 x 32·2	28.	13 x 33	48.	13 x 32	68.	12·5 x 32
9.	13 x 32·5	29.	13 x 32	49.	13 x 32	69.	13·5 x 32·5
10.	13 x 32·4	30.	13 x 32	50.	13 x 32·5	70.	13·5 x 33
11.	13 x 32·4	31.	13·2 x 32·5	51.	13 x 32	71.	13·5 x 32·5
12.	13 x 32	32.	13 x 32·5	52.	13 x 32	72.	13 x 32·5
13.	13 x 32·2	33.	13 x 33	53.	13 x 33·5	73.	13 x 32·5
14.	12·5 x 32·5	34.	13 x 32·5	54.	13 x 32	74.	12·5 x 32·2
15.	13 x 32	35.	13 x 32·5	55.	13 x 32·5	75.	13 x 32
16.	13 x 32	36.	13 x 32·5	56.	13 x 32	76.	13 x 32
17.	13 x 32·5	37.	13 x 32·5	57.	13 x 32·5	77.	12·5 x 32·5
18.	13 x 32·5	38.	13 x 32·5	58.	13 x 32	78.	12·5 x 32·5
19.	13 x 32·5	39.	13 x 33	59.	13 x 32	79.	13 x 32·2
20.	13 x 32·5	40.	13 x 33	60.	13 x 32·5	80.	13 x 32

258 x 642·5 = 258 x 642·5 = 258 x 644·9 = 258 x 644·6

81.	13 x 32·5	101.	12·5 x 32·5	257·5	645·6
82.	13 x 32·5	102.	13 x 33	258·7	649·5
83.	12·5 x 32·5	103.	13 x 32·5	258·5	646·9
84.	13 x 32	104.	13 x 32·2	257·9	646
85.	13 x 32·5	105.	13 x 32·5	257·3	643·8
86.	13 x 31·5	106.	13 x 32	257·5	645·3
87.	13 x 32	107.	13 x 32·4	1555·4	3873·4
88.	13 x 32·5	108.	13 x 32·5		
89.	13 x 32	109.	13 x 32·5		
90.	13 x 32	110.	13 x 32·5		
91.	12·5 x 32	111.	12·5 x 32·5		
92.	12·5 x 32·5	112.	13 x 32·5		
93.	13 x 32·5	113.	13 x 32·5		
94.	13 x 32·5	114.	13 x 32		
95.	13 x 32·5	115.	12·5 x 32		
96.	13 x 32	116.	13 x 32·5		
97.	13 x 32	117.	13 x 32·5		
98.	13 x 32	118.	13 x 32		
99.	12·5 x 32·5	119.	13 x 32·5		
100.	13 x 32	120.	13 x 32·5		

258 x 643·4 = 258 x 642·9

1555·4 : 120 = 12·96

3873·4 : 120 = 32·3

Average 12·96 x 32·3

120 Timbers 8 x 13·5 6"

1.	8 x 14·5	21.	8 x 14·3	41.	8 x 14·5	61.	7·5 x 14·2
2.	8 x 14·6	22.	7·5 x 14·2	42.	8 x 14	62.	8 x 14
3.	8 x 14	23.	8 x 14·2	43.	8 x 14·4	63.	8 x 14
4.	8 x 14·5	24.	7·5 x 14·5	44.	7·5 x 14·3	64.	8 x 14·2
5.	8 x 14·5	25.	8 x 14	45.	8 x 14·3	65.	8 x 14·1
6.	8 x 14·5	26.	8 x 14·2	46.	8 x 14·3	66.	8 x 14·2
7.	8 x 14·3	27.	8 x 14	47.	8 x 14·3	67.	7·5 x 14
8.	8 x 14·3	28.	8 x 14·2	48.	8 x 14	68.	8 x 14
9.	8 x 13·5	29.	8 x 14·2	49.	8 x 14	69.	8 x 14
10.	8 x 14	30.	8 x 14·5	50.	8 x 14·5	70.	8 x 14
11.	8 x 14·5	31.	8 x 14·3	51.	8 x 13·5	71.	7·5 x 14·1
12.	7·5 x 14	32.	8 x 14·3	52.	8 x 14·1	72.	8 x 14·1
13.	7·5 x 14·2	33.	8 x 14	53.	8 x 14	73.	7·5 x 14·4
14.	8 x 14·5	34.	8 x 14	54.	8 x 14·3	74.	8 x 14·5
15.	8 x 14·5	35.	8 x 14·5	55.	8 x 14	75.	8 x 14
16.	8 x 14·5	36.	8 x 14·5	56.	8 x 14·5	76.	8 x 14
17.	7·5 x 14·5	37.	8 x 14	57.	8 x 14·1	77.	8 x 14·1
18.	8 x 14·3	38.	8 x 14·5	58.	8 x 14·5	78.	8 x 14·5
19.	8 x 14	39.	8 x 14·2	59.	8 x 14	79.	8 x 14
20.	8 x 14·3	40.	8 x 14·2	60.	8 x 14	80.	8 x 14

158 x 221·1 = 158 x 221·3 = 158 x 221·2 = 158 x 221·4

81.	8 x 14	101.	8 x 14·1	178·6	237·1
82.	7·5 x 14	102.	8 x 14·5	178·6	238·3
83.	7·5 x 14	103.	8 x 14·5	180	238·4
84.	8 x 13·5	104.	8 x 14	179·3	238·4
85.	7·5 x 14·5	105.	8 x 14	177·4	236·4
86.	7·5 x 14·1	106.	8 x 14	179·4	238·4
87.	8 x 14·5	107.	8 x 14·5	1785·2	2372·8
88.	8 x 14	108.	8 x 14·1		
89.	8 x 13·5	109.	8 x 14		
90.	8 x 14·5	110.	8 x 14		
91.	8 x 14·5	111.	8 x 14·5		
92.	8 x 14	112.	8 x 14		
93.	7·5 x 14	113.	7·5 x 14·1		
94.	8 x 14	114.	8 x 14·1		
95.	8 x 14	115.	8 x 14·5		
96.	8 x 14	116.	8 x 14		
97.	8 x 14	117.	7·5 x 14·2		
98.	8 x 14·1	118.	8 x 14		
99.	8 x 14	119.	8 x 14		
100.	8 x 14·5	120.	7·5 x 14·4		

158 x 221·1 = 158 x 221·3 = 158 x 221·2 = 158 x 221·4

1785·2 : 120 = 7·968

2372·8 : 120 = 19·773

Average 7·968 x 19·773

120 fibres 8 x 13·5 6½"

1.	8 x 13·5	21.	8 x 13·6	41.	8 x 13·5	61.	8·2 x 13·5
2.	8 x 13·5	22.	8 x 13·9	42.	8 x 14	62.	8·2 x 13·5
3.	8 x 13·6	23.	8 x 13·9	43.	8 x 13·7	63.	8·2 x 13·5
4.	8 x 13·6	24.	8 x 13·9	44.	8 x 13·8	64.	7·5 x 13·5
5.	8 x 13·5	25.	8 x 13·8	45.	8 x 13·3	65.	8 x 14
6.	8 x 14	26.	8 x 13·5	46.	8 x 13·8	66.	8 x 13·8
7.	8 x 13·5	27.	8 x 13·7	47.	8 x 13·7	67.	8 x 13·5
8.	8·2 x 13·4	28.	8 x 13·5	48.	8·4 x 13·5	68.	8 x 13
9.	8 x 13	29.	8 x 14	49.	7·8 x 13·5	69.	8 x 14
10.	8 x 13·5	30.	8 x 14	50.	8 x 13·5	70.	8 x 13·5
11.	8 x 13·6	31.	8 x 13·5	51.	8·5 x 13·9	71.	8·6 x 14
12.	8 x 13	32.	8·2 x 13·5	52.	8·2 x 13·5	72.	8 x 13·8
13.	8 x 13·5	33.	8·5 x 13·5	53.	8 x 13·6	73.	8·5 x 13·5
14.	8 x 13·5	34.	8 x 13·6	54.	8 x 13·2	74.	8 x 13·5
15.	8 x 13·5	35.	8 x 13·8	55.	8 x 13·5	75.	8·2 x 13·5
16.	8 x 13·6	36.	7·8 x 13·2	56.	8 x 13·5	76.	8 x 13·9
17.	8 x 13·9	37.	8 x 13·5	57.	7·8 x 13·5	77.	8·2 x 13·5
18.	8 x 13·5	38.	8 x 13·6	58.	8 x 13·5	78.	8 x 13·2
19.	8 x 13·6	39.	8 x 13·5	59.	8 x 13·6	79.	8·2 x 13·2
20.	8 x 13·5	40.	8 x 13·8	60.	8·2 x 14	80.	8·2 x 13·5
	162 x 270·0		160·5 x 263·2		160·6 x 272·1		161 x 271·4

81.	8 x 14	101.	8·2 x 13·8	162	270
82.	8 x 13·2	102.	8·2 x 13·6	160·5	263·2
83.	8 x 13·4	103.	8 x 13·7	160·6	272·1
84.	8 x 13·5	104.	8 x 14	161.	271·4
85.	8·2 x 13·8	105.	8·2 x 13·8	161·1	271·6
86.	8 x 13·5	106.	8 x 13·5	162.	270·6
87.	8 x 13·5	107.	8·2 x 13·6	967·2	1618·9
88.	8 x 13·5	108.	8 x 13·5		
89.	8 x 13·5	109.	8·2 x 13·5		
90.	8 x 13·2	110.	8·2 x 13·8		
91.	8 x 13·8	111.	8·4 x 13·5		
92.	8 x 14	112.	8·2 x 14		
93.	8 x 13·5	113.	8·2 x 14		
94.	8 x 13·5	114.	8 x 13·2		
95.	8 x 13·8	115.	8·2 x 14		
96.	8 x 13·5	116.	8 x 14		
97.	8·2 x 13·8	117.	8 x 13·5		
98.	8 x 13·5	118.	7·8 x 13·6		
99.	8·2 x 13·6	119.	8 x 13·5		
100.	8·5 x 13·5	120.	8 x 13·8		
	1614 x 271·6		162 x 270·6		

967·2 : 120 = 8·06
1720
1618·9 : 120 = 13·49
418
589
1090
880

Average 8·06 x 13·49.

[ca. 1882-1884]

SOCIÉTÉ ÉLECTRIQUE EDISON

SOCIÉTÉ ANONYME

Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Paris 1881

GRAND DIPLOME D'HONNEUR

Paris, le 188

	c			c'		c' min
	8	candle	lamp	at 32	candle	152 "
	16	"	"	" 64	"	174 "
23	10	"	"	" 32	"	461 "
21	8	"	"	" 32	"	255 "
16	10	"	"	" 32	"	125 "
15	16	"	"	" 64	"	294 "
10	16 B	"	"	64	"	170 "
9	16 B	"	"	64	"	177 "
6	10	"	"	40	"	52 "
5	16 B	"	"	64		157 "
4	16	"	"	64		336 "
3	16	"	"	64		218
2	16	"	"	64		416
1	16	"	"	64		355

	8	candles	lamp at	32	candles	152 m.	400	hours
	16	"	"	64	"	174	458	"
m 23	10	"	"	32	"	461	536	"
21	8	"	"	32	"	255	668	"
18	10	"	"	32	"	125	145	"
15	16	"	"	64	"	294	773	"
10	16 B	"	"	64	"	170	446	"
9	16 B	"	"	64	"	177	465	"
6	10	"	"	40	"	52	136	"
5	16 B	"	"	64	"	157	411	"
4	16	"	"	64	"	336	883	"
3	16	"	"	64	"	218	573	"
2	16	"	"	64	"	416	1093	"
1	16	"	"	64	"	355	933	"

294 2.4 / 588 / 147 / 735

294 2.6 / 1764 / 588 / 964.4

1.16

294 2.8 / 2352 / 588 / 8232

461

461 / 11 / 1.16 / 2766 / 461 / 461 / 5553476

1.2

294 2.75 / 1470 / 2058 / 588 / 80850

1.2

1.16

145 / 125 / 200 / 125 / 750 / 750

125 1.2 / 250 / 125 / 1500

170 2.65 / 850 / 1020 / 340 / 450.50

294 2.65 / 1470 / 1764 / 588 / 779.10

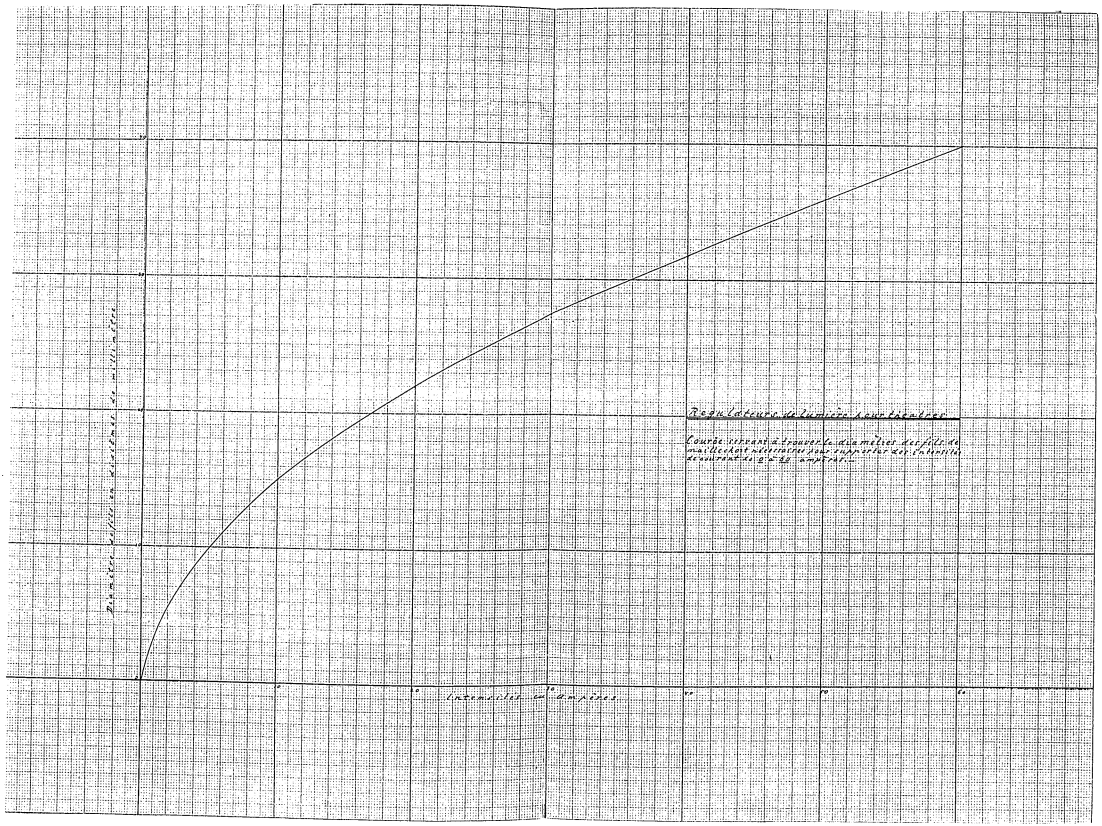
[ca. 1882-1884]

Tableau

des résistances pour signaux de sirènes.

Tirage	Intensité employée	Résistance totale en Ohms	Résistance de la bobine en Ohms	Résistance mesurée en Ohms	Résistance à ajouter en Ohms	Tirage	Intensité employée	Résistance totale en Ohms	Résistance de la bobine en Ohms	Résistance mesurée en Ohms	Résistance à ajouter en Ohms
1	0.7564	140.0	140.0	0	0	21	0.4144	253.22	176.0	77.22	9.06
2	0.7688	143.08	141.08	1.28	1.28	22	0.4183	244.91	177.0	86.11	8.89
3	0.7812	146.93	143.08	2.83	1.55	23	0.4224	237.88	177.6	59.95	9.84
4	0.7936	149.94	145.44	4.54	1.71	24	0.4316	232.26	181.4	108.86	10.91
5	0.7960	153.63	149.02	6.43	1.89	25	0.4640	302.19	183.2	118.99	12.13
6	0.8184	157.50	149.1	8.50	2.07	26	0.4664	317.55	185.0	132.55	13.56
7	0.8408	161.57	150.0	10.77	2.27	27	0.4688	334.55	186.8	147.75	15.20
8	0.8632	165.88	152.6	13.26	2.49	28	0.4712	353.42	188.6	164.87	17.12
9	0.8856	170.31	154.4	15.98	2.72	29	0.4736	374.66	190.4	184.26	19.39
10	0.9280	175.16	156.2	18.96	2.98	30	0.4760	398.55	192.2	206.35	22.09
11	0.9104	180.21	158.0	22.21	3.25	31	1.2880	425.69	194.0	231.69	25.34
12	0.9328	185.55	159.8	25.75	3.55	32	0.5000	456.21	195.8	261.21	29.52
13	0.9552	191.24	161.6	29.64	3.89	33	0.5232	492.33	197.6	294.73	34.22
14	0.9776	197.37	163.4	33.97	4.23	34	0.5288	533.02	199.4	333.62	40.39
15	1.0000	203.91	165.2	38.71	4.63	35	0.5880	585.41	201.2	383.91	48.29
16	1.0224	210.92	167.0	43.97	5.09	36	0.6104	645.54	203.0	442.54	58.63
17	1.0448	217.81	168.8	49.11	5.54	37	0.6328	713.39	204.8	508.59	72.55
18	1.0672	225.78	170.6	55.18	6.07	38	0.6552	813.67	206.6	607.41	91.92
19	1.0896	234.44	172.4	61.84	6.66	39	0.6776	935.73	208.4	727.33	119.96
20	1.1120	243.56	174.2	69.16	7.32	40	0.7000	1100.0	210.0	890.00	162.03

[ca. 1882-1884]


Régulateurs de lumière pour théâtres
Courbe servant à trouver le diamètre des fils de maillechort nécessaires pour supporter des intensités découvrant de 2 à 30 ampères.
Diamètre des fils en dixièmes de millimètre
Intensités en ampères

[ca. 1882-1884]

DYNAMO	WATTS	LENGTH OF LOOP IN ARM.COILS	LENGTH OF WIRE IN LOOP EXPOSED TO MAGNET.	RATIO OF EFFECTIVE WIRE TO TOTAL LENGTH OF LOOP.	RESISTANCE(COLD) TWO COILS IN SERIES.
No. 10	25000	57½	33	.574	37
No. 12	30000	60½	36½	.603	29.5
No. 16	40000	72½	41½	.57	22.7
No. 20	50000	81	49½	.611	21.
No. 32	70000	106	50	.471	16.3
No. 56	140000	113	50	.441	6.5

[ca. 1882-1884]

Prix du matériel électrique

pour les

différents types de machines

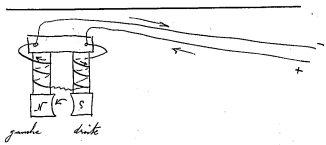
Matériel électrique	Prix unit.	25 lampes A16 Nombre	25 lampes A16 Prix	50 lampes A16 Nombre	50 lampes A16 Prix	120 lampes A16 Nombre	120 lampes A16 Prix	200 lampes A16 Nombre	200 lampes A16 Prix	300 lampes A16 Nombre	300 lampes A16 Prix	500 lampes A16 Nombre	500 lampes A16 Prix	1000 lampes A16 Nombre	1000 lampes A16 Prix
Installation industrielle															
Dynamos		1	1600	1	2500	1	4000	1	5000	1	7000	1	10000	1	15000
Régulateurs		1	100	1	100	1	150	1	150	1	200	1	250	1	500
Douilles à clef	6	4	24	5	30	10	60	15	90	15	90	15	90	20	120
Douilles sans clef	3														
Douilles en bois	1,50	21	31,50	45	67,50	110	165	185	277,50	285	427,50	485	727,50	980	1470
Commutateurs de 1 à 3	8,75	2	17,50	4	35	6	52,50	8	70	10	87,50	12	105	15	131,25
d° 3 à 8	15	2	[illegible]	4	[illegible]	5	75	7	105	9	135	12	180	15	225
d° 8 à 30	30					3	90	4	120	8	240	10	300	12	360
d° 30 à 80	45							1	45	2	90	4	180	8	360
Tableaux															
Coupe circuits principaux	3,50	2	7	2	7	4	14	6	21	8	28	10	35	12	42
d° doubles 1 à 30	2,40	2	4,80	4	9,60	8	19,20	12	28,80	16	38,40	20	48	25	60
d° d° 1 à 100	6,05					1	6,05	2	12,10	3	18,15	5	30,25	10	60,50
d° simples	1,75	8	14	15	26,25	30	52,50	60	105	90	157,50	150	262,50	300	525
Couvercles Noirs	0,50	4	2	8	4	15	7,50	30	15	45	22,50	75	37,50	150	75
Jaunes	0,75														
Bouchons de 1 à 3	0,30	8	2,40	15	4,50	30	9	60	18	90	27	150	45	300	90
d° 1 à 30	0,40	4	1,60	8	3,20	16	6,40	24	9,60	32	12,80	40	16	50	20
d° 1 à 100	0,80					1	0,80	2	1,60	3	2,40	5	4	10	8
Isolateurs grand modèle	0,06	[illegible]	3	75	4,50	125	7,50	250	15	375	22,50	500	30	1000	60
d° petit modèle	0,05		5	150	7,50	250	12,50	500	25	750	37,50	1000	50	2000	100
Moulures par lampe	3														
Fils usines	5	25k	125	50k	250	100k	500	175k	875	250k	1250	400k	2000	750	3750
" particuliers	6														
Ruban isolant, Kilog.	5	1	5	1,5	7,50	2	10	2,5	12,50	3,5	17,50	5	25	8	40
Montage			125		250		600		950		1350		2125		4000
Totaux			2097,80		3716,55		5837,95		7946,10		11254,25		16540,75		26996,75
Prix par lampe			83,912		74,331		48,649		39,73		37,514		33,08		26,996

Matériel électrique	25 l. A16 Nombre	25 l. A16 Prix	50 l. A16 Nombre	50 l. A16 Prix	120 l. A16 Nombre	120 l. A16 Prix	200 l. A16 Nombre	200 l. A16 Prix	300 l. A16 Nombre	300 l. A16 Prix	500 l. A16 Nombre	500 l. A16 Prix	1000 l. A16 Nombre	1000 l. A16 Prix
Installation particulière														
Dynamos	1	1600	1	2850	1	4000	1	5000	1	7000	1	10000	1	15000
Régulateurs	1	100	1	100	1	150	1	150	1	200	1	250	1	500
Douilles à clef	15	90	30	180	60	360	100	600	125	750	175	1050	300	1800
Douilles sans clef	8	24	16	48	55	165	94	282	167	501	315	945	688	2064
Douilles en bois	2	3	4	6	5	7,50	6	9	8	12	10	15	12	18
Commutateurs de 1 à 3	3	26,25	6	52,50	12	105	20	175	30	262,50	50	437,50	100	875
d° 3 à 8			1	15	2	30	4	60	6	90	8	120	12	180
d° 8 à 30							1	30	2	60	4	120	6	180
d° 30 à 80											1	45	2	90
Tableaux	1	25	1	50	2	120	4	200	5	300	7	500	10	1000
Coupe circuits principaux	2	7	2	7	2	7	4	14	4	14	6	21	8	28
d° doubles 1 à 30	2	4,80	4	9,60	8	19,20	12	28,80	16	38,40	20	48	25	60
d° d° 1 à 100					1	6,05	2	12,10	3	18,15	5	30,25	10	60,50
d° simples	8	14	15	26,25	30	52,50	60	105	90	157,50	150	262,50	300	525
Couvercles Noirs														
Jaunes	4	3	8	6	15	11,25	30	22,50	45	33,75	75	56,25	150	112,50
Bouchons de 1 à 3	8	2,40	15	4,50	[illegible]	9	60	18	90	27	150	45	300	90
d° 1 à 30	4	1,60	8	3,20	16	6,40	24	9,60	32	12,80	40	16	50	20
d° 1 à 100					1	0,80	2	1,60	3	[illegible]	5	4	10	8
Isolateurs grand modèle														
d° petit modèle														
Moulures par lampe		75		150		360		600		900		1500		3000
Fils usines														
" particuliers	25k	150	50k	300	100k	600	175k	1050	250k	1500	400k	2400	750k	4500
Ruban isolant, Kilog.	1	5	1,5	7,50	2	10	2,5	12,50	3,5	17,50	5	25	8	40
Montage		250		500		1200		2000		3000		5000		10000
Totaux		2381,05		4315,55		7219,70		10380,10		14897		22890,55		40151
Prix par lampe		95,24		86,31		60,164		51,90		49,656		45,78		40,15

[ca. 1882-1884]

1/

Machine de 100 lampes excitée par une machine 50 A, couplage des électros en série. —



Nombre de lampes en circuit = 100 pendant toute la durée des expériences. —

Résistance additionnelle dans champ magnétique de l'excitatrice = 0

Heures	Volts lampes	Température	Vitesse	Tempér. bobine	Volts excitatrice	Amp. courant excit.	Vitesse
9 heures	104	17°	1122	17°	135	2,4	1568
9 1/2		18°	1180				1570
10		19°,5	1215				1545
10 1/2		20	1200				1580
10 3/4		22	1220				1508
11		23,5	1234				1494
11 1/2		24,5	1232				1468
11 3/4		24	1230				1460
Midi		24	1240				1502
1 h		25	1262				1550
1 h 1/2		25,25	1244				1560
2 h		24,5	1272				1464
2 h 1/2		26	1278				1508
2 h 3/4		25,5	1275				1510
3 h		24,5	1250				1490
3 1/4		24	1288				1520
3 1/2		24	1270				1512
3 3/4		24	1278				1506
4		24	1266				1516
4 1/4		24	1278				1502
4 1/2		24	1280				1511
4 3/4		24	1285				1511
5		24	1260				1530
5 1/4		24	1234				1520
5 1/2		24	1250				1525
5 3/4		24	1250				1510
6 heures		24	1265	arrêt 32° après 10 minutes 44°			1512

2 essais, tenant les Volts aux bornes de l'excitatrice = 110

Heure	Volts lampes	Température	Vitesse		Volts excitatrice	Amp. champ.	Vitesse	Résist. intérieure
$1^h \frac{3}{4}$	89	24°	1412		110	1,6	1680	1/18me tombe
$2^h \frac{1}{2}$	72	24°	1074		110	1,8	1306	0

[ca. 1882-1884] [INCOMPLETE]

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs.

Paris, le _____ 188

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLÔME D'HONNEUR

Adresse Telegraphique
EDISON, PARIS.

3.

33, Avenue de l'Opera.

Machine for 200 lamps A Edison Fr. 2916
" " 300 " " " 4130
The improved 100 light machine [illegible]
present making

[illegible] the [illegible]
Siemens and Halske for sale to the public are as follows:—

Machine for	12	lamps	A	Edison	Fr. 1000
" "	25	"	"	"	" 1375
" "	40	"	"	"	" 2000
" "	100	"	"	"	" 3125
" "	150	"	"	"	" 4500
" "	200	"	"	"	" 5375

These are all compound machines —
The factory price at Ivry of machines with their regulators included are as follows:—

Machine for	17	lamps	A	Edison	Fr. 847
" "	25	"	"	"	" 960
"	50	"	"	"	" 1310
"	120	"	"	"	2466

[ca. 1882-1884] [INCOMPLETE]

4

Dr. Siemens kindly took me through his 'lamp factory' where I saw all the processes the carbon and glass went through during the manufacture of a lamp. ~~Although the tests show at the Vienna Exposition of Electricity that the Siemens lamp was the best after the Edison for satisfying the wants of domestic lighting yet the~~ processes ~~employed there~~ are exactly the same that [illegible] as far back as 1879. and are very [illegible] I do not think they [illegible]

[illegible] and Siemens and Halske relative to some changes to be made in the 200 light dynamo sent them from Ivry previous to their using it for a model for manufacture.

2. To look into the fact that the Deutsche Edison Gesellschaft have a strong competition from other manufacturers of small types of dynamos and see what can be done to remedy it.

As regards the former, I find the dynamos made by Siemens and Halske for the Deutsche Edison Gesellschaft from models sent from New York are much more elaborately finished than the ones we make at Ivry. The top part of the machine is entirely covered with polished mahogany, the leading

9 2 7 6 0 5 5 1
9 2 7 0 5 5 1
0 0 8 0 7 0 7
0 0 7 1 7 0 2
0 0 3 1 9 0 3

CHARLES BATCHELOR COLLECTION

1883

Please as

Batchelor

In account with Drexel Morgan and Company

1882		Dr		
Jany	4	To Dft #4	33	12
	13	" for C Cohne secy	117	20
Feby	20	" #6	40	
	27	" #7	10	
March	8	" #8	15	
	16	" #9	200	
	23	" #10	105	
May	2	" #12	126	
Sept	12	" #13	105	
		Balance	2,166	07
			$ 2,917	39
		Cr		
1881 Dec	31	By Balance as rendered	1443	78
1882 Jany	21	" Cash from S Insell	211	25
July	13	" Cash	579	86
Aug	14	" U S 4% Int	240	
Dec	2	" U S Treasy Interest warrant	442	50
			$ 2,917	39
		Cr		
		By Balance	$ 2,166	07

— E & O E — N. York January 30. 1883 —

[illegible]

The Edison Electric Light Company of Europe Limited

65 Fifth Avenue New York March 24th, *1883*

Charles Batchelor, Esq.

Dear Sir:-

After considerable difficulty with the Customs Officials here, we have at length succeeded in obtaining our Parts of Founder. The examiner at the Custom House wanted to charge us 25 per cent duly on the cost of the printing and paper, and we only escaped this duty from the fact that one signature was written. Had both signatures been stamped on the papers we should have been subjected to a delay of about a month until we could have obtained the cost from you.

We now beg to acknowledge the receipt of Two thousand one hundred and thirty eight (2138) Parts of Founder of the Société Industrielle et Commerciale Edison, namely, Certificates

Nos.	1 to 300	inclusive		300
"	351 to 900	"		550
"	1001 to 2288	"		1238
				2138

We also acknowledge receipt of Two thousand three hundred and seventy five (2375) Parts of Founder of the Société Electrique Edison, namely, Certificates Nos. 1 to 2375, inclusive.

We beg to Renew our thanks for your kind attention to this matter.

Yours very truly,

Second Vice President.

BANQUE CENTRALE
DU
COMMERCE
SOCIÉTÉ ANONYME
Capital: 25 Millions de Francs
27, RUE DE LA CHAUSSÉE D'ANTIN.

Paris le 28 mars 1883

Monsieur l'administrateur,

M. Porgès me charge de vous informer qu'il tient dès aujourd'hui à votre disposition les parts de fondateur de la Compagnie continentale qui reviennent à M. Edison et à la Light Company.

Le nombre total des parts étant de 8000, la partie qui doit rester en dépôt ici (2000) s'élève à 1600 ; sur les 6400 de surplus, il y a lieu de défalquer 800 attribuées à M. Léon ; c'est donc au total 5600 parts que M. Porgès doit vous remettre. Il vous prie de vouloir bien lui faire savoir le jour et l'heure où vous viendrez prendre livraison de ces titres.

Veuillez agréer monsieur l'administrateur, mes salutations dévouées,

Edmond

THE EDISON LAMP CO.,

Harrison, N. J., April 10, 188

C. Batchelor, Esq.,

2 14 East 18th St., N.Y.

Dear Mr. Batchelor:-

We have been compelled to pass our dividends for th reason that since the first of Jan'y we have had to reduce ours bills payable twenty two thousand dollard ($22,000). To pay dividends we would be compelled to go outside of our regular banking channels to borrow money. This I do not think it advisable to do, and although we made double the amount required for the dividends in each of the months, we had no spare cash for dividend purposes. We expect that you will get your dividends in the Fall in the shape of extras, and hope soon to resume the payment of the regular monthly dividends.

Very trulym yours

THE EDISON LAMP COMPANY

By Francis Ellison, Treas.

Théodore Puskas
19, rue d'Argenteuil
ADRESSE TÉLÉGRAPHIQUE
Puskas-Paris

Paris, le 30 Avril 1883

Monsieur Ch. Batchelor
Ivry s/s.

Je vous prie de prélever sur les Parts de Fondateur de la Cie Continentale Edison qui me reviennent 100 (Cent) de ces Parts et de les remettre à Monsieur Constant Rousseau, 113 Bd de Sébastopol, contre la présente.

Agréez, Monsieur, mes salutations empressées.

Théo. Puskas

Reçu de monsieur Batchelor cinquante fondateurs en parts conq. à cette lettre. — Paris, 1er juillet 1883 (Nos 5245 5344)
Fromage

Table showing Lives à Lampes de diverses Ht M.F. =

Est et which Lamps Lives. H Candles.

	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
90	1000	1300	1752	2269	2903	3663	4555	5614	6846	8258	9866	11700	13885	16468	19500	23000	27000	31500	36500	42000	48000
91	700	1000	1304	1672	2100	2611	3214	3917	4729	5654	6701	7884	9225	10750	12500	14500	16800	19400	22300	25500	29000
92	525	766	1000	1304	1652	2055	2506	3011	3571	4187	4861	5594	6390	7250	8200	9200	10300	11500	12800	14200	15700
93	410	586	763	1000	1266	1572	1920	2312	2750	3235	3768	4350	4980	5660	6400	7200	8050	8950	9900		
94	300	444	584	763	1000	1243	1520	1830	2175	2555	2970	3420	3910	4440	5000	5600	6250	6950			
95	230	34	450	587	770	1000	1220	1470	1750	2060	2400	2770	3170	3600	4060	4550	5070				
96	180	262	345	452	594	724	1000	1205	1434	1688	1966	2270	2600	2955	3330	3730					
97	145	212	280	366	480	585	714	1000	1190	1402	1633	1884	2157	2453	2765	3095	3445				
98	120	175	231	302	396	483	590	691	1000	1178	1372	1583	1812	2060	2322	2600	2893	3200			
99	100	146	192	251	329	401	490	574	666	1000	1143	1319	1510	1716	1935	2167	2410	2666	2933		
100	85	124	163	214	280	342	417	488	566	667	1000	1122	1284	1460	1645	1842	2050	2267	2494	2733	
101	73	106	139	183	239	292	356	417	484	570	666	1000	1145	1300	1466	1642	1827	2020	2222	2433	2655
102	63	91	119	157	205	250	305	357	414	488	570	666	1000	1136	1280	1434	1595	1764	1940	2125	2317
103	54	78	102	134	175	214	261	305	354	417	487	570	666	1000	1127	1270	1412	1562	1718	1882	2052
104	46	67	87	114	150	183	223	261	302	356	416	487	570	666	1000	1125	1250	1383	1521	1666	1816
105	40	58	75	98	129	157	192	224	260	306	358	418	489	571	666	1000	1111	1229	1352	1480	1614
106	34	49	64	84	110	134	164	192	223	262	307	359	419	490	572	667	1000	1110	1222	1338	1459
107	29	42	55	72	94	115	141	165	192	225	264	308	360	420	491	573	668	1000	1111	1222	1333
108	25	36	47	62	81	99	121	142	165	194	227	265	309	361	421	492	574	669	1000	1111	1222
109	21	31	40	53	69	85	104	122	142	166	195	228	266	310	362	422	493	575	670	1000	1111
110	18	26	34	45	59	72	88	103	121	142	167	196	229	267	311	363	423	494	576	671	1000

The Editor [illegible]

1883

Dear Sir,

I regret that before the meeting you have not spoken to me of your objection to see Hippel leaving the Belvie. Now it is too late and I will explain to you the reasons which militate in favour of this decision. The Germans have claimed us to give them somebody capable of mounting a manufactur of lamps, and you had nobody to send them. Or, as it is necessary to satisfy them, I give them Hippel, and I have obtained the command of the material which gives some work to Ivry. Since 1 year ½ that our Usine goes on, nobody has been initiated to all the secrets of the lamps, so that we are in reality in the hands of Hippel, who would not, I think, give his secrets ~~to~~ of fabrication to any other without ~~any~~ advantages for himself. I find it dangerous, and urgent to change it, Hippel might be ill & &c. I have been able to obtain for Hippel pecuniary advantages, which he could never have had at Ivry (12,000 francs for the year and his journey forward and backward. He leaves us quite satisfied he has explicitly promised me to divulge to his successor all the little secrets of the fabrication which he knows so well, and I absolutely believe in his word.

I have momentarily designed Belvie for

the direction of the lamps. He is of a good and easy character, in good terms with Hippel. Later I will put another person and keep Falcon in hand. It is probable that we shall have some difficulties to begin, but I am sure you will help us if necessary, my dear Master Watchelor.

For pray do not think of any personal opinion in the mesures, a little radical, which I am obliged to take, and which are far from agreable, I assure you. And if some are not of your opinion, tell it me frankly, without any intermedial, and I will explain them to you as plainly as the little english I know will allow me.

I am of your opinion that the lowest possible price of our lamps will make the public adopt more easily our system, but I find very impolitic this sudden diminution of value of the Américains, to engross the German commands, which have only been profitable to the German society and not to the public. The two Usines ought to agree between themselves of the minimum price of their produces, and only make themselves a good war for the quality. If you partake of my opinion, you ought to write to America in that sense.

Yours truly

Alf. Chatard

Coulonges 9 bre 1/83 —

The Edison Electric Light Company of Europe Limited

Edison

65 Fifth Avenue, New York August 16th. *1888.*

37

Charles Batchelor, Esq.

Ivry-sur-Seine,

France.

Dear Sir:-

We beg to acknowledge the receipt from you of Five thousand one hundred and seventy four, (5174) Parts of Founder of the Compagnie Continentale Edison, said Parts of Founder being numbered 1 to 5174, inclusive.

We have not yet received from you the certificate for the other 1000 shares coming to us.

Yours very truly,

Second Vice President.

1883

Statement regarding the unpaid claim of The Edison Electric Light Company of Europe, Limited, New York City, against the Compagnie Continentale, Paris, on account of the Edison Exhibit at the Paris Electrical Exposition.

THE ORIGINAL PROPOSED PUSKAS & BAILEY AND LEON CONTRACT.

The commencement of the Light Co's business in Paris was the proposed contract between Messrs. Puskas & Bailey and M. Leon, submitted by Mr. Bailey in the Spring of 1880, to the Light Co. for its approval.

It appeared, from that contract, that M. Leon wished to secure an option on the Edison system for Paris and suburbs, also a commission on the Edison business throughout France, and that he was willing to pay for this option the sum of 150,000 francs, or such smaller amount as it might cost to exhibit the Edison light in the Paris Electrical Exposition. It further appeared that Leon had doubts about the success of the light, consequently, as his option on Paris would not have much value if the light failed, the contract provided that if the light was a failure at the Exposition, the Light Co. would reimburse him. Puskas & Bailey deposited 1000 shares of their own stock in the Light Co. to secure Leon, incase the Light Co. failed thus to reimburse him.

This proposed contract was not executed. The Light Co. decided, with Leon's consent, that the contract had better be made

directly between the Company and him. Thereupon a new contract, with no substantial changes, was prepared and submitted to M. Leon through Mr. Wallerstein of New York. It was subsequently executed by the Light Co. and Leon, and is known as the Contract of June 8th. 1881.

CONTRACT WITH LEON, JUNE 8th. 1881. The main provisions of this contract, mentioned above, between the Light Co. and M. Leon were as follows:

(1) M. Leon was to have (1) the option until November 10th., 1881, to form a company for Paris and the Banlieu, (2) a commission on what the Light Co. might receive in case such company was formed, (3) a further commission of 5 per centum on all business done in France, and (4) the preference at equal price of all business done in France. This valuable option was afterwards extended, at Leon's request, until the end of February 1882.

(2) The Light Co. was to exhibit the Edison light at the Paris Exposition, using the money paid by Leon for the above option, to defray the expense, to the amount of 150,000 francs. If the light was not a success the Light Co. was to reimburse Leon, and Puskas & Bailey voluntarily left their 1000 shares of stock, above mentioned, in pledge to secure this repayment. The language of the contract (Section 3) is as follows:

"Leon binds himself to furnish to the Company such sum

of money as may be necessary to make an exhibition of the Edison system of Lighting at the said Paris Exposition, said sum to cover the cost of the entire plant, including machinery, wires, lamps, et cetera; together with freight thereon, and the actual compensation and expenses of such person or persons as may be sent or otherwise employed by the Company in connection with said exhibition." The total expenditure was not to exceed 150,000 francs (about $30,000).

(3) There are three points upon which the contract is silent as follows:

First. Who was to furnish any additional money required in case the amount furnished by Leon was not enough? The contract failed to provide for this, and, inasmuch as Leon declined to furnish any additional amount, the Light Co. made up the deficit. The total cost of the Exposition plant and exhibition was $51,261.65, of which Leon paid only $30,000., and the Light Co. paid $21,261.65, thus making up the deficit.

Second. Was Leon to be reimbursed the 150,000 francs in case the light was a success but he still not form the Paris Company? In other words, suppose he did not avail himself of his option, even though the light was a success, was he to be reimbursed? The contract does not provide for any such repayment. The contract, however, does provide that if the Light did not succeed, the Light Co. would reimburse Leon; also that if the Light did succeed and Leon formed the Paris company, he was to be repaid out of what the Light Co. would get. But the contract was silent

as to whether Leon's 150,000 francs should be repaid in case the light was a success but Leon did not form the Paris Company. This is an important point. The light was a success, yet Leon did not form the company, although he was in possession of the option to do so for nine months. Consequently, so far as the Light Co. is concerned, Leon had no right whatever to be reimbursed.

Third. Who was to own the exhibition plant, after the Exposition closed? This is a vital question, especially in view of the fact that Leon treated the plant as though he owned it, that is to say he took possession of the plant, sold it, and took the proceeds, all without the Light Co's knowledge or consent. What right had Leon to do this? The Light Co. asserts that he had no right, and the reasons for that belief are given below:

(1) It may be said that Leon furnished his money in order to acquire title to the plant, and that therefore it was his. There would be force in this statement, were it true, but the fact is, as shown by the contract, that Leon paid his money not to acquire title to the plant, but to secure title to something else, namely, an option for Paris. Leon paid the Light Co. a certain sum for a specific thing, the Paris option, and the Light Co. agreed to use that money for another specific thing, to make an exhibition. That arrangement is, as matter of law, quite a different thing from Leon paying his money to buy and own the plant. The contract is clear upon this point. Leon bought an option and had a right to sell it; the Light Co., instead of putting the money he paid for the option in its treasury, agreed to spend it in

buying a plant; and the Light Co. owned the plant. All the right that Leon had in the premises was merely to compel the Light Co. to expend the money it had received from him, in a specific way, viz: on the exhibition.

(2) Again, it may be said that Leon was entitled to take the plant, after the Exposition was over, just as he would have been entitled to take the proceeds of the plant provided the Light Co. itself had then sold it. Let us examine this. Would Leon have been entitled to take the proceeds of the plant? In order to detect the falacy of this, let us suppose a case. Suppose that when the Paris Exposition closed, the Light Co. had been fortunate enough to find a customer to whom it sold the plant for say 500,000 francs, and suppose the Light Co. had the money in its treasury. Could Leon have claimed that money under the contract? The plant, of course, had belonged to somebody who had a legal title to it, and that party, whoever he was, would have been entitled to these 500,000 francs. Would Leon have been entitled to that money? Most certainly not. Not only does the contract nowhere provide that the title to the plant was to pass to Leon, thereby possibly enabling him to reimburse himself out of the proceeds derived from such a possible sale of it; but Leon's sole right to be reimbursed is limited by the contract to only two circumstances, in either one of which, and in those events only, he was to be reimbursed.

These two circumstances, provided by the contract, wherein Leon was to be reimbursed are as follows: (1) In case the Light

proved to be a failure, and (2) In case Leon formed a Paris Company. Leon's right to have his money repaid was limited to these two cases. He has therefore no right, under the contract, to be reimbursed under the present existing circumstances, namely, the success of the light, but his failure to form a Paris Company.

It seems, therefore, to be clearly established by the above reasoning that if the Light Co., having sold the plant, had the proceeds in its treasury, Leon could not have taken title, under the contract, to the money. This is so not only because the contract did not give him title to the plant, but also because he was not entitled to be reimbursed his outlay in the event that actually happened, namely, the success of the light but his failure to form the Paris company within the nine months.

(3) But Leon may possibly claim the right to sell the plant and take the proceeds, as matter of equity and not of contract, on the ground that the money furnished by him was actually put into the plant! That is to say, he may choose to utterly ignore his legal status under the contract, and to claim that in equity he is entitled to what the plant brought. Even if the contract were thus set aside, and the matter were adjusted on a sort of equitable basis, even then Leon would not be entitled to the proceeds of the plant. Who paid for the plant? The total cost was over $50,000, of which Leon paid less than three fifths, and the Light Company paid the rest. Surely, even if the contract is to be set aside and equity is to prevail, Leon is not entitled to all the proceeds. Yet this is just what Leon has done. Although he paid for less than three fifths of the expense, he has

taken the entire proceeds and given the Light Company, who paid for more than two fifths, nothing.

WHAT THE LIGHT COMPANY CLAIMS. In view of what is above stated, the Light Co. feels justified in making the following claims against the Cie. Continentale:

(1) The Cie. Continentale has appropriated to its own use the property of the Light Co., without their knowledge or consent, and without paying them anything for it. That property is the Exposition plant. The Light Co. asks that this entire property be restored to its rightful owner, the Light Co., or that the entire value of it be paid to the Light Co. in money. The fact that the appraised value of the plant has been already paid to Leon is something the Light Co. has nothing to do with. That is a question to be adjusted between the Cie. Continentale and M. Leon. What the Light Co. asks for is either its property or the value of it in money, and it asks this of the Cie. Continentale.

(2) If the Light Co. is rightly informed, the Cie Continentale has repaid to M. Leon all the money he advanced on account of the Paris Exposition, including the 150,000 francs furnished to the Light Co. If that is so, that is to say if the Cie. Continentale has taken upon itself to pay M. Leon's outlay in connection with the Paris Exposition, the Light Co. asks to have its outlay also repaid. In other words, if M. Leon has been made

good as regrads what the Edison display cost him, the Light Co. asks that it may also be made good. Seemingly there is no fair ground for discriminating between M. Leon and the Light Co. in this regard, and the Light Co. fails to see any reason why the expenses of one should be paid and not those of the other.

(3) Referring to the two preceding paragraphs, the Light Co. claims from the Cie. Continentale the sum of $21,261.65. The total expenditure touching the exhibition plant was $51,261.65, of which M. Leon paid $30,000, and the Light Co. paid the balance. Full details of all these expenditures have heretofore been handed the Cie. Continentale, and also furnished to Mr. Bailey, in a letter dated September 15th. 1882. The following is a brief summary of the account:

1,000 Light Dynamo Account.....	$14,141.30
Edison Electric Light Co's bill for small Dynamos.	3,150.00
Mr. Edison's bill for boiler, lamps, fixtures, electrical supplies, cash disbursements.&c.....	33,970.35
Total Exposition Disbursements	$51,261.65
Received from M. Leon.....	$30,000.00
Present unpaid Claim of Light Co.....	$21,261.65

CONCLUSION. The Light Co. has endeavored to set forth above, calmly and fairly, the grounds of its claim against the

Cie. Continentale. If there is any error in this statement, either as matter of fact, or law, or argument, the Light Co. will be glad to have it pointed out; but otherwise, it feels that the claim should be promptly and fully allowed.

Office of The
Edison Electric Co.
of Europe, Limited,
No. 65 Fifth Avenue,
New York City,
September 14th. 1883.

S. B. Paine

Second Vice President.

Mr. Dot Chairs

T. A. EDISON,
65 Fifth Avenue.

New York, Sept. 21st. 1883

Charles Batchelor, Esq.

Paris, France.

Dear Sir:-

With relation to cables confirmed elsewhere, I beg to inform you that the prices given by me for fibres were in accordance with instructions which I had received from the Edison Lamp Co. Two or three days later, after talking it over with Mr. Upton, it was arranged to quote a lower price. When your letter came to Insull stating that Upton had given you a price lower than that mentioned by me or the Lamp Factory, I at once communicated with the Lamp Factory, and decided, after a consultation with them, to send you the cable above referred to.

As to the drawings for the 25 and 50 light dynamos, although the experiments on these machines have been made, we have not as yet got the models out, but we are expecting to get then out in a week or two and immediately this is done drawings shall be sent to you. The drawings of the 100 and 400 light machines will, I think, be sent to you by Tuesday's mail. The changes at the Machine Works have caused some delay in getting out these things, which you must accept as our apology for not sending them to you

earlier.

We yesterday tested the 300 light machine, which gave 260 amperes at 112 volts and the armature running at 1100 revolutions. This is a machine with one pair of cores and will be sold for somewhere about $1,000. We hope to send you drawings in about two weeks or may be a little earlier.

I cabled for your proxy for a meeting of the Light Company on the 24th. September, which meeting is to vote on ~~the~~ an increase of the Company's stock from $720,000. to $1,080,000. Thinking that the proxy would not reach here in time I cabled you this morning to sign a Power of Attorney authorizing me to vote your shares at any meeting of the Light Company, and requesting you to have Consul Walker confirm signature, so as to enable me to go on your Power of Attorney. I shall hope to get your reply tomorrow.

Very truly yours,

Thos. A. Edison

J.

Hopkinson
Sept 28
1883

4, Westminster Chambers,
TELEPHONE No 3092.
Victoria Street, S.W.

28th Sept 1883

Chas Batchelor Esq.

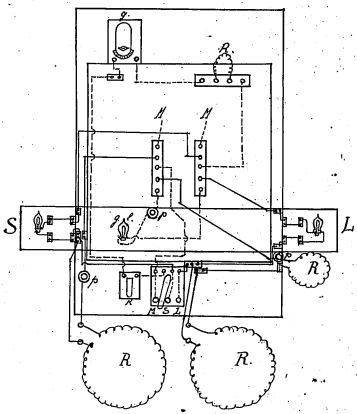
My dear Sir,

I would have answered your letter sooner but I have been very busy since my recent return from Switzerland. As to Sprague's test — being made not for me but from a critical point of view I did not think it necessary to suggest to him tests of long running. However it is easy to see what is fairly the capacity of the machine. The old L had six strands of No 16 wire to carry 150 lights. The Sprague machine had 8 strands of No 16 and if these wires were as closely packed would carry 200 lights with the same facility they are not so closely packed consequently it will carry more. The new H has 14 strands of No 16 to carry 500(?) lights at this rate the Sprague machine would carry 286 lights or

indeed rather more as the trees were less closely packed.

But since Sprague was with me we have further improved about 30% and we have not quite finished yet.

Yours very truly
J. Hopkinson



portable photometer. (Vissieres).
10/2 – 1883.

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Grand Diplôme d'honneur

PARIS 1881

Ivry-sur-Seine, le 1er Decembre 78

Chas Batchelor Esqr

Paris

My dear Sir,

In reply to your letters of 30th ult. we beg to inform you that we have not in stock any copper to make tubes of No 1/2 and that we would require at least two months to make them.

It appears to us that it would be necessary for the Society to have a complete stock of tubes of all Nos ordered at same time as the fabrication of a few tubes at a time entails, as you are aware, a loss on the factory.

Regarding the tableau for Nice, we shall inform you that we received the ~~[illegible]~~ castings from the foundry yesterday; we shall push this order forward as quickly as possible.

As regards the particulars of the shipments to Nice asked by Mr Quatravaux we may say

that the same were sent to Mr Felix Martin Commissaire Général of the Nice exhibition and were put on the bill we sent the Sté Electrique as well. We shall however send by this evening's mail a copy of same to Mr Quatrans according to your desire.

We await your reply relative to the seekeling moulds for Germany before commencing work on the castings we have here.

Yours faithfully

SOCIÉTÉ Indus^le et Comm^le EDISON

R. V. Picou

Picou
Dec 1883

4 Dec '83

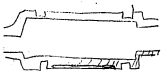
My dear Batchelor;

I have just rec'd your telegram about the point in the patents. — We all want to think that this point does not hurt us; but you know that English counsel was very much afraid to go into court on it. It seems to me that we must look at the question of union in to pick ourselves on a large [illegible] Here is one consideration. — We should be stronger with Swan than without him; and there is no use in our disguising that our situation is a good deal weaker than we all thought it. In the next place Swan is our only real competitor and the

union in England forces the policy on us. It will give me confidence in our people, and I think even if the whole of the charge of royalty came off of the part, 1, 2, 15 to 20% of what comes to me, what remains would be worth more than the whole, without the union. The moral effect would be very great, for Swan is a competitor. I hope you will not do anything to unsettle the idea for the management right there. We are going on a very unsteady course. Everybody when I left Paris wanted it, & I beg of you not to let Mr Page's violence and positiveness make you give up your own

[2]

good judgment. I think get the Company to go on with the pipe but with the help of Morris until when the factory is permanent. Could you not get the Mannesmann finished and the Canal factory in order to pay two to three months and then go to Italy. Then go to Germany but I think come home & tell me what you think of this. We have got to have patience and economy in our expenditure time more than we have had so far all go to the bottom, I am getting my money off, altogether and my health is much improved so that when I come back shall be able to help to get our affairs straight. What you give time to thinking and [illegible]



him to copy it and take
copy on loose sheets, and
keep it for me, as I have
no clerk. Yours sincerely

J. F. Bailey

Please telegraph me a simple
word tomorrow "agree" or
"disagree" with above.

Bailey
Dec 23

22/1380 | 60
1380
28

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Grand Diplôme d'honneur

PARIS 1881

Ivry-sur-Seine le 6 Décembre 1883

5, RUE DU PARC.

N° 606.

Doit Monsieur Ch. Batchelor

Paris

5524 - Imp. Lemercier 23, r. Lafayette

9 mbre	1	Une caisse d'emballage :				
		6 mètres planches de 4 traits	.	37	2	10
		Clous et vis	.	.	1	70
		Main d'Œuvre 4 h. à 70 C.mes	.	.	2	80
.	18	Une caisse d'emballage d'une machine à coudre :				
		7 mèt. planches de 5 h.	.	70	3	70
		Main d'Œuvre et emballage	.	.	3	50
		Clous et vis	.	.	.	70
		3 Caisses	.	.	19	10
		Camionnage	.		5	.
		Total		Frs.	38	20

[DECEMBER 8, 1883] [FROM THOMAS A. EDISON]

Télégramme

BATCHELOR PARIS +

Charles

16 rue de la Bienfaisa

A DÉCHIRER

Timbre à date.

PARIS CENTRAL 8 DEC 83 SEINE

Pour _____ de _____ N° _____ Mots _____ Dépôt le _____ à _____ h. _____ m. du _____

PARIS DE NEVVYORK 149 22 VBR +

PREPARE YOURSELF RETURN IMMENSE BOOM BUILDING THIRTEEN CENTRAL STATIONS

RESULT RETURNS NEVVYORK STATION VVHICH NETTED OVER FIVE THOUSAND NOVEMBER +

EKNOSIDE

41 Conduit St. W.
8 Dec '83

Paiger
Dec 83

Mr Rae Batchelor,

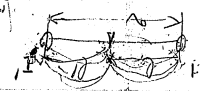
I have given directions to stenographer to mail you tonight copy of a long letter sent to Eaton on the proposed new company. The greater part of it is in answer to a long letter of inquiries from Eaton. Pray read it carefully and tell me if you are of accord. I enclose a copy of a cable which I propose to you to send on our joint names. It should be sent at the charge of the Cie Continentale. I have mailed Eaton copies of Sions & my letters which show

$$x = \frac{200 \times \sqrt{16}}{\sqrt{16} + \sqrt{9.1}} \quad \frac{200 \times 4}{4 + 3}$$

$$7 \overline{)800}$$
$$114.3$$

$$365 \overline{)14000}$$
$$1095$$
$$3050$$
$$2920$$
$$\overline{)38}$$
$$19$$

$$\frac{200 \sqrt{16}}{\sqrt{16} + \sqrt{16}} \quad \frac{800}{2}$$



all the discussion we have had on points of fusion &c, — I am trying to get German matters fixed and to prevent a general row with them. The worst thing in our relations with them, also what exasperates them the most is the system of petty deceit in our whole action. Bismarck thinks he is clever enough to conceal. — I shall get to an agreement with Swan before I leave, the first day, perhaps two. I think it certain. My dear fellow if you think the letter I wrote Ran & Morgan give the Nat. Saxons for doing it you think me a little cracked no doubt. But I will tell you Saxons enough if when I

[2]

see you. Some of the Nat. Saxons you will see are in my letter to Eaton; perhaps I shall have time to write about take my letter to Eaton & give it to him. The week, if it is being pushed off and we are — if you think they are lightly bound. Once you write he thinks they will come together when I come back. Dann Mr. Arnold with Jerry in mind I am sorry "Rush" you would write me carefully what is going on from the point of view of what he is officially, Dyspepsia Chamber & Politics; but you never do tell me what I really want to know. Remember me to Mrs. Bailey, you know, or do you prefer Bailey, Yours truly, J. D. Bailey

Moses Dec 1881

SOCIÉTÉ ÉLECTRIQUE EDISON

SOCIÉTÉ ANONYME

Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Paris 1881

GRAND DIPLOME D'HONNEUR

Paris, le Dec 10 1881

Dr O. A. Moses
155 E. 17th St
New York.

My dear Dr.

I have made some very extended experiments on the practicality of working arc-lamps in our circuit and amongst others your's.
I find I can work any lamp (demat) under the conditions that I propose equally well — I believe your lamp is simple to make and could be used by our company in many cases & if we could come to some arrangement I should propose them for the Opera here which we are going to light with 5000 incandescent & 100 arc.

I have spoken about royalty to pay for manufacture here and I believe an arrangement could be made for a royalty of 20% of the selling price which I should advise as 200 Frs or 225 Frs.

Gramme - Cents	250 - 300
Dance	260 - 320
Siemens	300 -

At 200 Frs cents

Manufacture	80
Royalty	20
Commission	40
	140
Profit of Company	60
	200

London 10 Dec '83

Mydear Batchelor: I did not think of taking on the Edison interest the whole weight of the arrangement with Swan but said if it were borne &c only as an illustration of its advantages.

Saturday they wanted 1/3 of royalty and founders shares, but that was blowing and I told them I couldn't negotiate from that as a starting point on their part. — Today I told them that I might go so far as 1/3 of royalty and 10% of what comes to us as founders shares, but that that was the limit, I have the idea to offer 16 1/3 % of royalty and founders shares in a lump, and to go at need to 20% of royalty and shares. Please write me tomorrow mail what you say to this; or if you don't get this in time telegraph me a word tomorrow evening as I expect a decisive meeting on Wednesday.

I shrink out of the letter to Eaton

2

The paragraph on 1st page, that "Lion had written me that thanks to the letter sent on Sunday they had agreed" &c. It was what he wrote me. But I did not notice in delaying the rather strong personal flavor of it, as I did when I read it now.

Yours sincerely

J. F. Baily

Baileys
Dec'd 1883

London 14 Dec 83

My dear Batchelor:

I dont write Ran any details of Swan matter, because (1) we have the largest stake in the matter, and (2) something different is talked every day and if I sent anything they would get fixed on that or some variation of it and then nothing can be changed without a row. So you can keep to yourself till I come back. — The last proposition that Forbes had under consideration from me was 1/3 of royalty and 10% of parts of founder. Whitebottom brought back this morning a confirmation of their demand for an equal division of the royalty on the lamp and I think no parts of founder. Our talk however was very hurried as we was bound into Court and we have meeting tomorrow at 10 to talk over carefully. If the above

2

Bailey Dec 1883

is a clear proposition on their part, I think I shall come square as an ultimatum to the offer of 20% of all, which would be a very fair modification of their offer and exchange for it, i.e. they would give up 30% of royalty for 20% of profits. As you found 16 2/3% about fair, I dont think you would grumble at 20, if that could close the matter. If you would not favor that you must telegraph me, if you dont tel, I shall assume you agree to it.

Another way would be to propose to them 1/3 of royalty and £10000 or £15000 in shares, of the new company, i.e. £250000 to 400000 fr. This would throw part of the weight of the purchase on the capital direct. If they could get out money so as to make a dividend they would be very glad of it. Or we might say to the

capital, give them 500,000 of
his shares of the new company and
we will give them 15% royalty on
the lamp, without raising the
royalty, higher than 30 centime,
and the New York co to get 2½%,
net of all commissions, of profits
I fourth: or 20% if we can't
do better. — I may be here
till Tuesday or Wed. though
I shall get through tomorrow
or monday with Swan. because
I must raise some money
for maturing obligations at
Paris and to live on. I am
unused to this business like
a galley slave, but I mean to
go over to the States in April
for a couple of months. Leon
writes me his account that the
fusion of the Man Col and the

Organation. If the Man Co. can be completed, as we
I think they can, it is the game, but in haste
I should think it practice, but don't get excited
I keep all pro and don't take any responsibility to
agreeing to a third engagement you don't believe
it necessary, I can't get full principle. Yours truly
Most of you don't do it don't take risk or ill. It is
all be thrown on you — I will and then we the Americans
so Hunnewell me tomorrow or Sunday, yours and
Mrs. you to write & write here, — R.B.P. cable
about funds, don't do nature. Yours truly
F.D. Bailey

COPY. Rec'd. Jan 4 1884. Paris, 29th Dec. 1883.

Major S.B.Eaton,

President.

My dear sir:-

Herewith enclosed you will find two projets of contract, the one relating to certain proposed modifications in the Statutes of the Compagnie Continentale Edison in consequence of the fusion of the three Companies of Paris; and the other a contract proposed to be passed between Mr.Edison and the Banque Centrale du Commerce, by which the latter is authorized to represent the parties of the first part in carrying out the proposed fusion and the reconstitution of the Compagnie Continentale.

In the following memorandum, the numbers, Art.I, 6, etc. refer to the corresponding numbers in the existing Statutes of the Compagnie Continentale and the present projet relates only to changes it is proposed to introduce in these Statutes. In the course of next week the entire body of Statutes, as they will finally stand, will be mailed to you.

ART.I.

The first change proposed to be made is in the object of the Company. You will notice that the exploitation of the patents of Mr.Edison is the leading object of the Company. but it

may also, under the final clause introduce any modifications or additions to the Edison system that it may find desirable. I have heretofore said to you, that it was found necessary during the period of formation to insist in all the contracts made on the limitation of the object of the Company to the exploitation of the inventions of Mr. Edison, because otherwise, it would have been difficult to show any reason why the royalties and interests demanded should be given. With the development of the business and the necessity of finding large capitals, a restriction indispensable in its earlier stages would be fatal. The public taking note of the great number of persons engaged in investigations and applications of electricity, to the subject of these contracts and the claims put forward in their behalf, would not have confidence to put money in a Company, whose possibilities were entirely limited to the inventions of a single man not only in the present but in the future.

ART. 6.

This paragraph provides for the suppression of the control in sales or licenses under the patents. The subject has been heretofore presented to you and I find it unnecessary to make any further explanation, only repeating what was said under Art. I. that it is indispensable to the finding of any large capital that the Company should have the disposition of its own ~~xxxxxx~~ business

ART. 7.

This Article relates only to changes in the amount of the share and of the capital.

ART. 18.

Increases the qualification of Directors.

ART. 24.

Authorises the appointment of a Committee of Direction, and is based on the experience of the present Board that it is impossible to secure from the entire Board the degree of attention considered necessary here to be given by the Directors. It is therefore proposed to name a Committee of the persons most largely iterested and most acquainted with the affair, who will give close and constant attention to it.

ART. 29.

Provides that the qualification of a stockholder to take part in a general meeting shall be increased to 20. Inasmuch as the shares were formerly of Fr.2,500 and five were required as a qualification, there is no substantial change involved, and I pass and Art. 35 without comment.

ART. 37.

This is one of the Articles which touches vitally the interests of the Light Co. At present the right of veto is vested in the Light Co., but as I have heretofore written you, it is impossible, in forming a large company that an act possibly vital to the success or even the existence of a company, should be subject to the decision of another party entirely independent of the company, and beside that a foreigner.

It might be proposed that the vote of three-quarters or of one half of the entire body of the shareholders should be

necessary in order to make a fusion; but this, though unobjectionable in theory, might be almost as injurious in practice as the right of veto by a foreign company. As a matter of fact, in France, shares in such a company are broken up in very small holdings, and it is found difficult to secure a representation of even one-half of the capital for the stockholders meetings. The requirement then of the vote of a large proportion of the total capital, might in a given case be disastrous to the interests of the founders, as well as of the shareholders. It was proposed by Mr. Porges and his friends that the vote of three-quarters of the shares represented should be necessary for a fusion; but to this I objected that it is very easy for the persons directing the company to pack a meeting and to secure such a proportion of the shares actually represented.

We have agreed finally on the adoption of a provision that no fusion can ever be made, which diminishes the number or the value of the parts of founder, and this we and our counsel find to be the most effective check possible to introduce. The precise wording of this clause may not be decided for several days to come as it is one of the points that must be debated between counsel, and I am only able to communicate to you the principle on which the matter will be settled.

ART. 43.

The clause of importance to the immediate interests of the Light Co. is the providing for a fund of amortisation of 10 per cent to be taken from the profits.

It is to be remarked concerning this that the substantial interests of the Light Co. are in no way affected by this provision but the immediate value of the parts of founder would be to a certain extent affected by such a clause. To illustrate this I submit to you herewith a memorandum showing what would be the disposition of profits in a given case.

The Counsel of Administration has always the right to provide for the amortisation of the capital and if nothing were said in the Statutes, there would be no limit to the exercise of this right. Ten per cent is not, according to usage, a large proportion to set aside for this purpose, but as it affects the immediate value of the parts of founder we insist on placing this limit at 5 per cent instead of 10. It is, as you will see from the above, for the interest of the Light Co. that a provision should be made for amortisation, and that for the immediate value of the parts of founder this limit should be as low as possible. I cannot assure you that the 5 per cent will be accepted but think it will.

ART. 44.

This Article provides for the payment of a royalty of 25 centimes on every lamp employed or sold by the Company as a charge on receipts, and before the payment of interest or profits.

It was proposed to make this royalty 25 centimes so long as the net price of sale of the lamp should be Fr.2,50, and that it should be reduced in proportion as the net sale price should go

below that figure. It has been conceded , however, to make the royalty a fixed royalty, not subject to scaling.

It was also proposed that the payment of the royalty should be limited to the sales or employment of lamps made in co ntries for which the Edison patents are conceded, but it would be difficult to maintain a control in this sense, and it is agreed that the royalty be paid as above. It will be necessary, however, to provide in this case that on all sales of lamps made by Mr. Edison or the Light Co. in the countries of the continent of Europe conceded to the Compagnie Continentale, a royalty or charge of 25 centimes be paid to the Compagnie Continentale. It is evident that the company could not at the same time pay a royalty and support a competition from the party to whom it was paid.

As to the countries for which the patents are not conceded, probably the best arrangement will be an agreement for uniform prices between the Compagnie Continentale and Mr. Edison and the Light Co. This matter, however, remains for fuller discussion.

THE CONTRACT BETWEEN MR. EDISON AND THE LIGHT CO. AND THE BANQUE CENTRALE DU COMMERCE

It is proposed that the Banque Centrale du Commerce be made the agent for the carrying of the arrangement for the liquidation of the Societe electrique and the Societe industrielle and the fusion of the three companies, according to the projet

above set forth.

In Articles I. and 2. the general conditions in which the liquidation and the fusion are to take place are set forth, and and also the considerations given on the one side and the other, as between the Compagnie Continentale, Mr. Edison and the Light Co.

In Article 3 it is stipulated that the consideration to be given to the Banque Centrale is 2,000 of the 8,000 parts of founder given for the patents, that is to say, IO per cent of the 40 per cent of profits, augmented by the 25 centimes royalty on the lamp. This IO per cent is to be disposed of to the various parties making up the new syndicate, as consideration for their subscription and cooperation.

360 parts of founder of the Compagnie Continentale have ~~been~~ been given to Puskas & Bailey and 70 as a supplementary commission to various persons interested.

800 parts of the Compagnie Continentale, i.e. 10% have been given to Messrs Porges and Léon together with 25 per cent of the parts of founder of the Societe industrielle and I6% per cent of the parts of founder of the Societe electrique.

Concerning the parts of founder of the two latter companies given to Puskas & Bailey, they simply fall in, as the engagement with the Light Co. was to give them 5 per cent of what it received.

Concerning the parts of founder of these two companies given to Leon & Porges the same condition does not exist.

Probably the real reason why Mr. Porges desired the fusion of the Electrique and the Industrielle only, though it has not been avowed, was that in the fusion of these two companies, he and his associates would have remained with 25 per cent of the parts of founder in the new company, instead of 25 in the one and 16 2/3 in the other and would have held the parts of the Compagnie Continentale for a further advantage in the reconstitution of this company, which was recognized by all to be inevitable in the future.

Concerning the arrangement to be made of the parts of founder coming to Leon & Porges in the fusion of the thre companies, there has been a great deal of warm discussion, both among themselves and with me, and it has been really, though not avowedly, the great obstacle in bringing about the consent to a fusion of the three companies.

Were the parts of founder in all the companies, except the Compagnie Continentale, allowed simply to fall in as in the case of Puskas & Bailey, the division would stand as follows:-

2,000 parts	to the new syndicate,	which equals		10 %
800 "	to Leon & Porges,	"	"	4 %
360 "	to Puskas & Bailey,	" "	"	about 1 7/8 %
70 "	to divers persons,	"	"	about 0 1/8 %

Total 3,230, which leaves nearly 23 3/8 to the Light Co.

It has been finally agreed, however, that the Light Co. shall stand with 22 of the 40 given to the founders net of all commissions to

Puskas & Bailey and divers, and the distribution will be as follows on the basis, to wit:-

New syndicate	2,000	which	equals		I0 %
Old syndicate	I,070	"	"	about	5 1/4 %
Puskas & Bailey	360	"	"	"	I 7/8 %
Divers	70	"	"	"	0 1/3 %
	3,500				

In former distributions Leon & Porges stood with an average of a trifle more than I7 per cent of the parts of founder in the present they will stand with I3 1/8. The points in question have been strained to the last and the results now proposed to you I think are the limit of concession that can be obtained.

There would remain then to the Light Co. under the proposed new distribution, 4,500 of the parts of founder out of 8,000.

You will have noticed from the above and from the projets that the consideration the new syndicate gives for the 8,000 parts of founder is the engagement to furnish Fr.6,500,000 of new capital. The half of this amount is to be paid up at the moment of constitution, and no provision is introduced making it obligatory to pay the remaining Fr.3,500,000. Were such a provision intro-

duced in the present condition of exchanges, it would make it impossible to do anything whatever.

The guarantees that the remaining Fr.3,250,000 will be actually called and paid up within a very short time are the following:-

I. This new capital is created specially to carry out the Paris central station, the estimates for which have been made up by Mr.Batchelor; these estimates after having been largely increased, in order to meet all contingencies, still show a profit so large as to create a positive conviction in the minds of persons so pessimist as Mr.Porges. This station cannot be carried out without purchasing the land, involving an expenditure of, in round numbers Fr.1,750,000 . The estimates call for Fr.3,523,298 in addition to the above. Besides this it is necessary to employ about Fr.500,000 to buy out the two-thirds interest in the factory property belonging to a Societe civile, and at least Fr.500,000 more is to be carried to the factory account as rolling capital, the entire lack of which for several months past, has constituted a great embarrassment and danger.

You will remark that the whole of the three millions and a quarter proposed to be paid up at the constitution of the company will be necessarily absorbed before advancing very far with the Central Station.

But besides this there are many demands for the employment of capital in large isolated or small compact central stations, to

the carrying out of which no risks attach such as attach to the Central Station of the Rue Basse Rempart (Opera), e.g. the lighting of the Bon Marché and the central station of the Palais Royal, in which large profits are fully assured.

To meet these demands for capital in excess of what would be realized from the call of the entire ten millions, probably the land of the central station will be mortgaged for a million or a million and a quarter.

II. It is quite certain that the substantial direction of the new company will remain in the same hands as at present and the above is the programme fully decided upon.

III. The employment of the new capital now proposed will give a demonstration that the business is a paying one, or to the contrary. If the former result is demonstrated, capital will seek the business, if to the contrary, there will be no occasion for discussing parts of founder from any point of view.

The above indirect guarantees are strengthened by the fact that the subscribers to the new capital will be the first banks of Paris and very likely Germany, Holland and Belgium.

You may ask yourself:- Why is it necessary to give a premium to a syndicate now, and what certainty is there that when another augmentation of capital shall be found necessary, a further demand for a division of the parts of founder will not be made? The answer to this is, that no business of central station exists in Europe capable of giving substantial assurance to capitalists that a profit can be made from the business. All the Electric

Companies that have been formed in Europe, with the exception of the three Paris Companies, have made large losses, the greater part of them of their entire capital. This has not occured in Central Station exploitation but the fact is fully as prejudicial as though it had.

Under these circumstances it is entirely out of the question to go to the public, and capital can only be obtained by giving to a strong group of bankers a premium for the risk they take in subscribing capital that is to be offered later to the public. Under all the circumstances the profit growing out of this is so problematic that the demand for a portion of the parts of founder, that is, to share in the future of the enterprise, is a legitimate one which it is impossible to pass. You must bear in mind that the enterprize of general illumination is still on trial as truly as at the epoch of the Paris Exposition. Besides the special prejudices existing against investment in all electrical enterprizes, the proposed new organization has to encounter almost the worst conditions of the money market.

There is one question relating to the means of control possessed by the Light Co., for assuring the payment of royalties and profits engaged in the present contract, which I purposely left for separate discussion. In Art. 6 of the present Statutes of the Compagnie Continentale a provision was introduced at my instance in view of the period when the Light Co. could not name Directors that a person named by the Light Co. and Mr.Edison might always assist at meetings of the Board of Directors with a consulting voice but without vote. In discussing the suppression of control

etc., I have insisted on retaining this provision. It has been urged against it, ~~and with reason,~~ that it would be impossible to allow a person outside of the Board of Directors, named by a foreign company, to be present at meetings where current business is discussed, and to be aware , not only of its acts, but of its intentions. You will no doubt recognize this as well founded.

Mr.Pouillet, who has been retained as the adviser exclusively of the Light Co. in matters relating to the proposed fusion, advises that a person named as above be allowed to take knowledge of the accounts of the company and of the minutes of proceedings of the Board of Directors.

Against this again, it is urged that the holders of the parts of founder receiving a royalty payable even before the dividend to the shareholders, have a primordial right to take such steps at any and all times as they may deem necessary for the assurance of their part of the profits, and that this right would be weakened and limited by insisting on ~~the appointment of a special person.~~ any special provision for control, Mr.Pouillet accepts the principle of this declarstion, while for the present making some question as to the unlimited practical conclusion drawn from it. The matter will be fully discussed between counsel and I do not think you have reason to make any opposition whatever the decision may be. The persons who are nominally your adversaries have almost the same amount of interest as you in taking all necessary security against the future Administration of the Company.

The above covers substantially the points requiring immediate consideration.

Concerning the Swan fusion and some other points I shall send another letter by Wednesday's courier.

I am, dear sir,

very respectfully & truly yours,

signed J. H. Bailey

SOCIÉTÉ INDUS.elle & COMM.le EDISON

Société Anonyme. Capital : 1.500.000 Francs.

à Ivry S/ Seine, 5, Rue du Parc.

Grand Diplôme d'honneur
PARIS 1881

Ivry, le 31 Décembre 1883.

Monsieur Batchelor

Administrateur de la Sté Industrielle et Cle Edison.

Nous avons l'honneur de vous adresser notre chèque N° 7905 sur la Banque Centrale de Frs 846.65, montant de vos jetons de présence pour le deuxième semestre de l'année, selon une décision du Conseil d'administration du 3 Décembre.

Agréez Monsieur nos sincères salutations

SOCIÉTÉ Indusle et Comle EDISON

R. V. Picard

[1883]

Société Industrielle et Commerciale Edison.

Société Anonyme, Capital : 1.500,000 Francs

Exposition Internationale d'Electricité

Grand Diplôme d'honneur

Paris 1881

Ivry-sur-Seine, le

5, Rue du Parc.

Lamp factory.

Month.	4 cand.	50 cand.	100 cand.	A 10	A 32	A 16	B 16	B 8	Total
December 1882						135		24	159
January 1883						1133		902	2035
February "						351		335	686
March "				7	8	1065		584	1664
April "				22		793		78	893
May "					12	533	40	159	744
June "				695	380	1691	101	1689	4556
July "				767	286	5676	6	1641	8376
Aug. "			6	465	10	3266	101	1050	4898
Sept. "			10	175	62	2973	25	1016	4261
Octob. "	7		2	36	134	4453	1	3398	8031
Nov. "	25	2		684	58	5626	52	2128	8575
Dec. "	4		2	816	103	3623	51	2441	7040
Resistance lamps						1037			1037
	36	2	20	3667	1053	32355	377	15445	52955

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

loss of zinc sulphate by evaporation made good, otherwise the cells need no care and will last two or three months, when they must be cleaned out and recharged. The internal resistance of the cells is high and must be determined and allowance made for it - unless worked over a very high resistance circuit they polarize quickly and appear inconstant but if your galvanometer circuit has a very high resistance so you only use about .00005 Ampere from the battery it will be very constant.
In order to determine what the E. M. F. of the battery is we use a calorimeter shown in the accompanying sketch - It consists of a copper can capable of holding a lamp and 1/2 lb. of water it is provided with a circulator for preventing the hot water accumulating at top - and a thermometer passes through a hole in the cover - We use it as follows - The E. M. F. of our batteries is about 75 Volts

[INCOMPLETE]

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

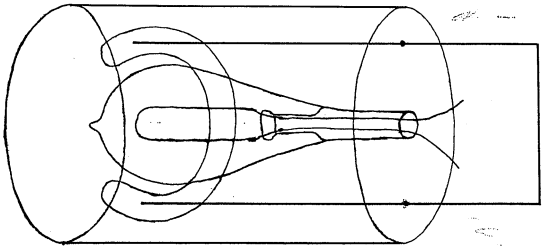
we have a testing circuit the E. m. F. of which is kept constantly 100 volts - we use in our calorimeter a low volt 32 candle lamp the resistance of which is about 90 ohms when working with 75 volts - in series with the calorimeter lamp is a fixed resistance coil of large german silver wire the resistance of which is 90 ohms - the lamp with its resistance ~~is~~ put across the 100 volt line - By taking the deflection on our galvanometer with the lamp and its resistance separately we can measure the resistance of the lamp under the conditions in which we use it - the two deflections being nearly equal errors of scale are avoided - In using the calorimeter we cool the water 5 degrees below the temperature of the room and allow the heat of the lamp to raise it from this point ten degrees - thus avoiding errors from conduction from or to the air and unequal radiation - Knowing the amount of water in the calorimeter

[INCOMPLETE]

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

the rise in temperature - the time occupied by the test - the resistance of the lamp and the water equivalent of the calorimeter vessel & lamp we can determine the E.M.F. acting over our lamp - this gives us the value of the deflection of the galvanometer and consequently the E.M.F. of our battery.



In measuring the E.M.F. of all our lamps we use a circuit of 100 volts - it is the sole duty of one man to keep this constant.

[INCOMPLETE]

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

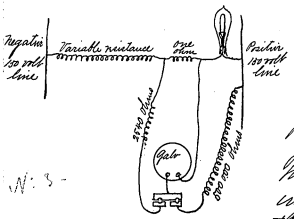
matching the deflection of a dynamometer and controlling the resistance in the field - this dynamometer is kept right by comparison with our Thomson Galvanometer which is standardized as shown before - The dynamometers in which the lamp readings are made are standardized by comparison with the field dynamometer and their adjustment proved by readings taken on ten standard lamps - these lamps also check the lamp used as a standard of light - Readings are taken on these ten lamps every morning and occasionally during the day - thus keeping our readings constant and our volts the same from day to day - The deflection of our field dynamometer produced by 100 volts has not changed over 1/8 of an inch in six months - We use 110 cells like the one described arranged in two parallel rows of 55 each - this combination gives us 55.5 volts - by taking readings on each row we can detect any

[INCOMPLETE]

THE EDISON LAMP CO.,

East Newark, N. J., ... 188

fault in either row and remedy it. In taking readings of E. M. F. we use our galvanometer without any shunt - inserted with 500 000 ohms and make our adjustments by raising or lowering our damping magnet - the magnet slides with a sleeve which is moved by a screw rendering nice adjustment easy - To determine the economy of a lamp we measure its E. M. F. and current, to enable us to read both on the same galvanometer we use the adjustment shown in the sketch - The lamp is brought to the required candle power by changing the variable resistance then by putting the plug in one hole we get a deflection over the lamp - one volt producing one m. m. deflection - then by changing the plug to the other hole we get a deflection over



N: 3 -

[INCOMPLETE]

THE EDISON LAMP CO.,

East Newark, N. J., _____ 188

the one ohm in circuit with the lamp—one one hundredth of an ampere gives one m. m. deflection on the same scale—

The enclosed drawing shows our arrangement of photometers and dynamometers in the testing room—showing a dynamometer for "A" lamps one for "B" lamps and a "field" dynamometer—the last is placed right across the line and the deflection upon its scale is kept constant by a man who watches it and controls the resistance in the "field" of the dynamos on this line—75 volts on the "B" dynamometer produce the same deflection as 150 volts on the A dynamometer—The A dynamometer can be thrown right across the lines; and the "B" dynamometer is standardized by comparison with the A—whenever need—

Respectfully
John W. Howell

[ca. 1883]

Confidentiel

Mémorandum des conditions de fusion de la Société Anglaise Edison-Sevan.

1° Les deux Sociétés vendent tous droits de brevets matériel etc à la Unité Compagnie.

2° La Unité Compie prend à sa charge toutes les dettes et obligations des Sociétés Edison et Sevan.

3° Le Edison reçoit :

A. 5000 actions de cinq livres chacune, complètement libérées

B. 40000 livres en actions de cinq livres chacune à moitié libérées

C. Une action de jouissance de cinq livres complètement libérée pour chaque trois actions A libérées dans le total de son capital. Ces actions de jouissance touchent après que les actions de préférence ont reçu 7% et dans l'éventualité générale il leur est attribué une voix par chaque deux actions.

Les actions de capital reçoivent 3/4 et les actions de jouissance reçoivent 1/4.

Swan reçoit :

A. 12.039 actions de 5 livres complètement libérées ;

B. 49.260 actions de 5 livres à moitié libérées.

La Société Swan ne reçoit pas d'actions de jouissance ; ces actions sont attribuées à Edison sans donner paiement des brevets.

Du premier capital, Edison a reçu 20.000 livres à titre d'avance sur les redevances lui revenant. Les 20.000 livres lui sont définitivement acquises par le traité de fusion.

Quant à l'attribution à Edison de 6000 actions complètement libérées et de 40.000 actions de 5 livres à moitié libérées et à Swan de 12039 actions de 5 livres complètement libérées et de 49260 actions de 5 livres à moitié libérées, la base de cette répartition ne ressort pas du traité même de fusion.

A ce sujet nous avons télégraphié à Londres et on nous a répondu que l'attribution du capital à chacune des deux sociétés était faite pour couvrir le passif de ces sociétés et que les 6000 actions complètement libérées attribuées à Edison lui étaient données comme prime. De plus Edison a reçu environ 20.000 actions de jouissance en paiement de ses brevets.

Ci-joint un télégramme provenant de Arthur Hopkinson électricien consultant de la Société Anglaise

[ca. 1883] [MEMORANDUM BY FRANCIS R. UPTON]

B 4

EDISON LAMP COMPANY.

THOMAS A. EDISON, PRES'T.
FRANCIS R. UPTON, TREAS'R.

EAST NEWARK, ... 188

Central Station Work

A $6\frac{1}{2}'' \frac{8 \times 13\frac{1}{2}}{1000}$, B $3\frac{1}{4}'' \frac{8 \times 13\frac{1}{2}}{1000}$

Isolated Work

A $6\frac{1}{2}'' \frac{8 \times 17}{1000}$, B $3\frac{1}{4}'' \frac{8 \times 17}{1000}$

10 candle A $6'' \frac{6\frac{1}{2} \times 9\frac{1}{4}}{1000}$

16 candle B $4\frac{1}{2}'' \frac{16 \times 25}{1000}$

32 candle A $7'' \frac{10 \times 27}{1000}$

50 candle A $8'' \frac{13 \times 32}{1000}$

100 candle A $9'' \frac{12 \times 70}{1000}$

12 candle B $4'' \frac{12 \times 21}{1000}$

These sizes are liable to be changed if our lamps are running extra good or poor. The sizes for the add lamps are largely experimental and need modifying to bring the economies closer to the economy at 16 candles

CHARLES BATCHELOR COLLECTION

1884

Ed Co for Is. Lighting

Mr. Batchelor,

Here is a copy of a statement of the Isolated Co's which I have just prepared here. Thinking you might like a copy for your files, I send you this. Please acknowledge.

S. B. Eaton

Jan. 5th. 1884. per Mc.G.

[ENCLOSURE]

To the Directors of the Edison Company for Isolated Lighting.

Gentlemen:-

For the information more especially of the new Directors who have not been connected with the Company heretofore, I have prepared the following financial statement, a copy of which is now furnished to each Director.

Respectfully yours,

65 Fifth Avenue,
New York City,
Dec. 27th. 1883.

President.

---

(1) How much cash has the Isolated Co. received from its stockholders?

ANSWER: The capital of the Isolated Company was originally $500,000., of which $255,000. was issued to the parent company. The original stock was doubled December 30th. 1882, and the same amount has again been issued to the parent company. Fifty per centum in cash has been called in on the increased stock.

Cash received on original capital.....	$244,985.00
Cash received on increased capital.....	107,718.66
Total Cash.....	$352,703.66

---

(2) Who are the delinquents on unpaid installments of the stock of the Isolated Company, and to what amount?

[ENCLOSURE]

ANSWER. The delinquents are as follows:

On first Capital: Fanny N. Howe..... $15.

Only 50 per cent has thus far been called in on the increased capital. A few stockholders chose to pay up the whole amount of their installmtns, instead of paying only the 50 per cent called in, and the total amount thus received in excess of the 50 per cent called in is $2,150.

The only delinquents on the installment of 50 per cent on the increased capital are those holding the Edison stock, as follows:

T. A. Edison.....	465 shares.
Chas. Batchelor.....	73 "
Rosanna Batchelor.....	4 "
	542 shares.

Total amount still owing on the above, $16,931.34

We have arranged to accept dynamos from Mr. Edison in payment of these installments.

---

(3) How much do the Light Co. and the Illuminating Co. owe the Isolated Co.?

ANSWER. The Illuminating Co. owes the Isolated Co. $4,141.97, on current account for material supplied. The Light Company owes the Isolated Co. $20,109.81, being the balance of an

[ENCLOSURE]

old account chiefly for cash loans; also, say, $15,000., one half the cost of the Roselle plant.

---

(4) What amount of promissory notes has the Isolated Co. now outstanding, and to whom were they given?

ANSWER.

Machine Works.....	$26,268.03	
Bergmann & Co.....	9,067.97	
Lamp Co.....	4,000.00	
Ansonia B.&Cop. Co.....	4,174.51	
Killey & Co.....	2,050.00	
Armington & Sims Co.....	6,109.14	$51,680.65
Due in December.....	$10,529.36	
" " January.....	18,214.70	
" " February.....	21,445.09	
" " March.....	1,500.00	$51,680.65

---

(5) What was the date of the last dividend of the Isolated Co.; also of the last annual meeting?

ANSWER. The last annual meeting was Nov. 20th. 1883. The last dividend (being 10 per centum, the only dividend declared thus far); was declared by the Directors December 5th. 1882, and made payable January 20th., 1883.

[ENCLOSURE]

(6) What were the total gross sales of the Isolated Co. prior to December 31st. 1882; also from January 1st. to December 1st. 1883?

ANSWER.

Gross Sales of the Isolated Co. from its organization Nov. 1881, to Dec. 31. 1882.....	$535,466.13
Gross Sales from Jan. 1st. to Dec. 1st. 1883.....	402,909.42
Total gross sales to Dec. 1st. 1883.....	$938,375.55

(7) What was the amount of Contracts closed by the Isolated Co. in the five months of July - November, 1882 and 1883, severally?

ANSWER.

Contracts closed in above 5 months in 1882...	$190,797.44
In same months, 1883.....	$199,333.15

(8) What are the amounts received by the Isolated Co. for renewals of lamps in the five months of July - November, 1883, and the amount of profit thereon?

ANSWER. The renewals were as follows:

[ENCLOSURE]

1893.	Cost.	Charged.	Profit.
July.....	$395.00	$ 975.00	$ 580.00
August.....	858.80	2,022.00	1,163.20
September.....	1,239.72	3,043.00	1,803.28
October.....	1,175.30	2,961.00	1,785.70
November.....	1,068.00	2,669.50	1,601.50
	$4,736.82	$11,570.50	$6,833.68

(9) What is the amount of the Isolated Co's cash capital tied up in plants of a permanent nature, or which possibly may be returned because customers may possibly refuse to keep and pay for them; and what are the chief items of same?

ANSWER. The following is the last:

Roselle Station.....	$29,073.85
Columbus, Ohio, Plant.....	1,714.36
Niblo's Garden.....	2,886.34
Nathan & Dreyfus.....	3,228.27
Light & Force Co. (in suit).....	3,458.11
Fairbanks & Co.....	2,379.90
Bijou Theatre, Boston.....	18,223.37
Foreign Exposition.....	11,148.23
Nonantum Worsted Mill.....	8,660.75
Whiting Paper Co.....	2,093.75
	$82,866.93

[ENCLOSURE]

The above, together with $20,189.81 owing to the Isolated Co. by the Light Co., and $4,141.27 owing by the Illuminating Co., makes a total of $107,178.71 of the Isolated Co's capital not available.

Below is given an explanation of each of the items making up the above amount of $82,866.43.

The Rosello Station has been wholly paid for by the Isolated Co., and the Light Co. agreed to pay for one half, but has not yet done so. Taking this experimental station at its actual cash value now, there might be a possible loss on it, at the utmost, of $20,000. It is suggested, for certain reasons, that the Light Co. assume a greater portion than one-half of this amount, say three-fourths of it, in which case its share of this estimated loss would be $15,000.

The Columbus, Ohio, plant was put in to assist in exploiting the Ohio business. We have been trying to sell this plant to the proprietors of the Ohio State Journal, whose premises it now lights, but have not yet succeeded. Should the sale not be made, and the plant be taken out, the loss will be possibly $1,000, of which, we think the Light Co. should bear one half.

Hible's Garden. We sold the light for use in "Excelsior". The piece is now withdrawn, and the plant will be taken back into stock, probably with only a nominal loss.

Messrs. Nathan & Dreyfus desire us to give a written guarantee that the operation of this plant will cost less than the same number of gas jets. The Isolated Co. does not give such guarantees, and it is doubtful whether the plant will be kept by

[ENCLOSURE]

Nathan & Dreyfus. If we have to take this plant out there may be a possible loss of one half, say $1,700.

The Light & Force Co. do not pay for this plant sold to them and we have brought suit to recover the amount. They give no reason for refusing, but are probably hard up. For the purpose of estimating our assets on a solid basis, it might be well to consider this item as worth only fifty cents on the dollar, being a loss of say $1,700.

Messrs. Fairbanks & Co. tried to operate their plant by water power, but they found it too unsteady. We are trying to sell them a steam engine to run their plant. If they do not buy one, the plant may have to be taken out. In that case there would be a possible loss of $1500.

The Bijou Theatre plant. We sell light to the proprietors of the theatre. We have just made a contract to light the theatre for another year from this plant. It is hard to tell what this plant is worth, but assuming it is worth only what the material would bring if the plant were taken out, sometime in the future, there would be a possible loss of say $9,000. The Light Co. ought to assume one half of this loss.

The Foreign Exposition. We also sell light from this plant. The Exhibition will be closed in about 2 months, when the plant will be taken out, certainly, Mr Fordon says without any loss.

The Nonantum Worsted Mills had some trouble with the engine which we sold them, and they would not pay until everything

[ENCLOSURE]

was all right. We expect to settle this matter within 2 or 3 weeks. Possibly we may have to make a deduction, say, at the utmost, 10 per centum on this bill. In that case there would be a loss of $900.

The plant of the Whiting Paper Co. was installed subject to their approbation. They may purchase it. If they decline to purchase and we have to take the plant out, there might be a possible loss of $1,000.

To sum up there may be the following possible losses on these items, in order to reduce them to a solid valuation, viz:, Rosella $5,000. (one quarter); State Journal $500. (one half); Nathan & Dreyfus $1,700; Light & Force Co. $1,700; Fairbanks $1,500; Bijou Theatre $4,500. (one half); Monantum $900.; and Whiting Paper Co. $1,000. Total, $16,800.

---

(10) What is the average length of credit which the Isolated Co. now gives in its business?

ANSWER. The average length of credit given is nominally until 30 days after the completion of a plant. The time of the actual collection of an account, however, depends upon the size of the installation. Generally speaking, our accounts are collected within 60 days from the delivery of the dynamo to the customer, but many stand much longer. In time we can be more rigid touching prompt pay, but not until the business is older.

---

(11) What proportion of the Isolated Co's purchases

[ENCLOSURE]

does it pay cash for, and for what proportion does it give notes?

ANSWER. The Isolated Co's purchases for the five months of July - November, 1883, averaged $78,518. per month, of which an average of $56,835. per month was paid in cash, and the notes given averaged $21,683. per month.

---

(12) What were the Isolated Co's expenses prior to January 1st. 1883; what have been the actual expenses from January 1st. to December 1st. 1883; and what are the estimated expenses up to the end of the year 1883?

ANSWER.

Expenses prior to January 1st. 1883.....	$71,991.65
Expenses from Jan. 1st. to Dec. 1st. 1883....	73,417.85
Estimated Expenses for December 1883.....	6,000.00

---

(13) What is the present cash capital, in money, available for the business of the Isolated Co.?

ANSWER. The total cash received has been $352,703.66, but a large portion of this is permanently tied up, as appears by the items enumerated in the answer to Question No. 9, amounting to $107,178.71, leaving $245,524.95 available cash capital now absorbed in the current business. The gross sales for the year 1883, are considerably less than twice this amount of available capital. Do we require so much capital for such an amount of sales? Undoubtedly we do for the present, because, first, we are obliged to pay cash for two thirds of our purchases (see Ques. No.

[ENCLOSURE]

11) and, second, we have to carry a very large stock of supplies; including dynamos and miscellaneous electrical apparatus. Next year we hope to have to carry less supplies and possibly after another year we may be able to turn our capital over more than twice a year, but it cannot be done just yet.

---

(14) How many selling agents does the Isolated Co. employ, and how are they paid?

ANSWER. The entire country is divided into sub-agencies, each in charge of a special agent. Some of them represent both the Light Co. and the Isolated Co., the expense being divided. The following is a list.

	Isd. Co.	Lt. Co.	Total.
H. A. Clark, Rent, Office & travelling expenses, average per month.	79.98		79.98
Salary, on a/c of commissions.	100.00		100.00
C. A. Benton, Salary.....	50.00	50.00	100.00
T. H. Teall, do	50.00	50.00	100.00
John E. May, Travelling expenses, average per month.....	32.91	32.92	65.83
C. T. Hughes, Salary.....		100.00	100.00
W. P. Dix, Salary on a/c of commissions.	125.00		125.00
W. F. Brewster, Salary.....		200.00	200.00
do Average travelling expenses per month.....		165.00	165.00
B. F. Card, Salary.....	100.00		100.00
do. Travelling expenses, average per month.....	29.60		29.60
Spencer Borden, New England Dept.	300.00		300.00

[ENCLOSURE]

	Isd. Co.	Lt. Co.	Total.
S. B. Paine, New England Dept.....	250.00		250.00
J. Bordon, Jr. " " " ...	200.00		200.00
H. L. Hand, " " " ...	100.00		100.00
C. D. Stickney, " " " ...	100.00		100.00
C. S. Price, " " " ...	125.00		125.00
W. Hodgkinson, " " " ...	100.00		100.00
G. D. Bancroft, " " " ...	125.00		125.00
Monthly agency expenses....	$2075.40	$597.42	$2673.41

Or $32,080.92 per annum.

Of which,

Light Co. pays monthly...	$ 597.92	
Isolated Co. pays monthly.	2,075.40	$2,673.41

Some of the above agents receive a stated salary, and in addition, a commission of 10 per cent on sales. Other of the above agents receive only a commission, but are guaranteed a certain sum per month on account of such commissions. We have also other selling agents who receive no regular compensation, but only commissions on their sales. Some of this class receive their travelling expenses, others do not. In this latter case the commission is 15 per cent on the selling price of dynamos. The large expense of the New England Department, mentioned above, is borne entirely by the Isolated Co. The Light Company pays this department for services in the shape of a commission, not included in the above statement because it is in addition to the amount paid by

[ENCLOSURE]

the Isolated Co., and is also an unknown quantity depending on the capitalization of central station companies formed.

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(15) What are the assets and liabilities of the Isolated Co. as shown by its last balance sheet?

ANSWER. The balance sheet of November 30th, shows as follows:

ASSETS.

Property accounts.....	$203,403.94
Open accounts.....	63,049.55
Customers.....	206,785.39
Miscellaneous.....	30,297.97
Expense account.....	75,972.51
	$580,108.36

LIABILITIES.

Cash Capital.....	$352,753.66
Accounts and Bills payable.....	83,942.11
Commission accrued.....	11,457.00
Open accounts.....	1,536.63
Property balance 1882.....	18,453.65
Gross Profit 1883.....	111,965.31
	$580,108.36

---

(16) What were the profits up to Dec. 31st. 1882, and what has become of them?

[ENCLOSURE]

ANSWER. The estimated profits were....		$91,789.57
Dividend paid.....	$50,000.00	
Deductions.....	22,863.65	
Commissions to agents and Gen. Manager.....	5,245.00	78,108.65
Balance of Profit and Loss..		$13,680.92

Since the profits were made up on Dec. 31st. 1882, it has been found necessary to make certain deductions on plants sold last year, the aggregate of which is $23,863.65. This amount has been charged to profit and loss during the present year, being losses on last year's sales, and is therefore deducted from the estimated profits of last year. All these old accounts have now been straightened out, and all the allowances and losses charged to profit and loss account.

---

(17) What are the profits from January 1st. to Dec. 1st. 1883?

ANSWER.

Gross Profits.....	$111,965.31
Deduct expenses.....	83,192.53
Profit to Dec. 1st. 1883.....	$ 28,772.78
Add estimated net profit for December.....	12,000.00
Profit on Louisville Exposition.....	5,240.51
Total net profit for year 1883.	$ 46,013.29

From these profits certain deductions should be made, in

[ENCLOSURE]

order to reduce all the assets to a conservative, solid basis. These deductions are discussed below:

(1) The property account is $203,403.94. This includes the Rosello station, $29,073.85; the Columbus plant $1,714.36; Niblo's $2,886.34; the Louisville Exposition $41,525.86; Bijou theatre $18,223.37; and the Foreign Exposition $11,143.23. Total $104,57201. Three of these items are worth par, viz. Louisville, Foreign Exposition and Niblo's; the others are worth less than par, and deductions have been made on them as elsewhere explained herein, (see Ques. No. 19). Deducting from the total property account of $203,403.94, this sum of $104,572.01, there remains $98,831.93, being the amount invested in dynamos, lamps, engines, and miscellaneous apparatus. This is all worth par, except the old style dynamos. We have been paying to the Edison Machine Works $550. for the old Z dynamo, 60 lamps, being $8.16 per lamp; whereas we now pay them only $250. for the new 50 light dynamo, being $5. per lamp. Again we used to pay $900. for the old 150 light dynamo, being $6. a lamp; whereas the new 200 light dynamo now costs us only $725., or $3.62 a lamp. We can readily sell the old style dynamos on the same basis as the new ones, but not otherwise, consequently their value must be reduced, and they must be estimated at the same cost per lamp as the new dynamos now cost. That being done, there will be a loss of say $7,000. on old dynamos now in stock, which is the only reduction that ought to be made touching the investment in material. All the rest of it is worth par.

[ENCLOSURE]

(2) The total amount of customer's accounts and other open accounts on the books is $320,443.29. Whenever accounts have been settled at a loss, or plants have been taken out, the loss has been promptly charged to profit and loss, consequently these accounts are generally in a healthy condition, except as below, viz:

(a) Commissions advanced to agents under contracts but not yet earned by them, amount to about $7,000. which may be a possible loss.

(b) If the loss on the Roselle plant, as above, is divided between the Light Co. and the Isolated Co., so that the latter bears but one fourth, the loss to it will be $5,000.

(c) If the loss on the Ohio State Journal plant, being $1,000. as above, is divided equally between the Light Co. and the Isolated Co., the latter's share will be $500.

(d) There is a possible loss, at the very worst, of $1,700., on the Nathan & Dreyfus plant; also the same amount on the Light & Force Co.; also $1,500. on the Fairbanks plant; also a possible loss of $500. on the Monantum plant; and a possible loss of $1,000. on the Whiting Paper Co. plant.

(e) Regarding the Bijou Theatre plant, there is a possible loss of $9,000., half of which, in my judgment, ought to be assumed by the Light Co.

Assuming that the Light Co. will bear its share, as above named, of the estimated loss on the Roselle plant, the Ohio State Journal plant and the Bijou Theatre plant, the losses then

[ENCLOSURE]

on customers and other open accounts, to be charged up against the profits of the Isolated Co., in order to reduce things to a solid basis, will be as follows:

Dynamos (old style).....	$7,000.00
Agent's Commission.....	7,000.00
Roselle (one quarter).....	5,000.00
Ohio State Journal (one half).	500.00
Nathan & Dreyfus.....	1,700.00
Light & Force Co.....	1,700.00
Fairbanks.....	1,500.00
Nonantum.....	900.00
Whiting Paper Co.....	1,000.00
Bijou Theatre (one half).....	4,500.00
Total.....	$30,800.00

which would reduce the profits of 1893, to - $15,213.29. The profits on the business prior to 1893, after having paid last year's dividend and after making all deductions and charging them to profit and loss, are $13,690.92. Taking the assets on a solid and conservative basis, this makes a total profit at the present time, available for dividend, of $28,904.21.

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(10) What are the losses touching experimental and advertising plants, which we think the Light Co. ought to bear a part of?

ANSWER. The following is a list of all the losses of this kind already charged up to profit and loss on the books of the Isolated Co., and following this list are the losses not yet charged up to the Isolated Co.

[ENCLOSURE]

charged up to profit and loss:

Mechanics Fair, Boston.....	$ 5,282.89
Borden Block, Fall River.....	2,231.49
N. Y. Post Office.....	2,179.50
Colorado Co.....	1,507.69
Southwark Foundry - Gas Engine.....	150.73
Albany Capitol.....	502.51
Cincinnati Exposition.....	3,007.51
Total.....	$15,352.32

It seems but fair that the Light Co. should bear one half of this total loss, because it was all incurred in advertising the business in such a general way that the Light Co. has benefited fully as much as the Isolated Co. If this is done the Light Co. would assume $7,676.16 on account of this loss.

The following is a list, not yet charged to profit and loss on the books of the Isolated Co., in which we think the Light Co. ought to bear its share as follows:

Rosello (one fourth, the Light Co. having already assumed two-fourths.).	$ 5,000.00
Columbus Journal (one half).....	500.00
Bijou Theatre (one half).....	4,500.00
Total.....	$10,000.00
Add one half of loss already charged to profit and loss on the books of the Isolated Co. as above.....	7,676.16
Total loss which the Light Co. ought to bear as its share.....	$17,676.16

[ENCLOSURE]

Another general remark should be made as bearing on the equity of our asking the Light Co. to bear the above share of this loss, viz., that owing to the failure of the Light Co. to enforce its patents against infringers, an active business competition in isolated plants has arisen, the Maxim Lamp being the chief competitor, whereby our business has been somewhat reduced both in volume and in profits. Indeed it is now questionable whether the Isolated Co. ought to be compelled to pay , and can afford to pay, to the Light Co. fifty-one one-hundredths of its profits for a license to carry on a business under patents which are not enforced and which do not create a monopoly.

---

(19) What dividend can we now pay?

ANSWER. The present cash capital (see Ques. No. 1), is..... $352,700.00

The Light Co's stock amounts to..... 382,500.00

Total amount on which dividend would be paid. $735,200.00

The balance of profits on the business ending December 31st. 1882 (see Ques. No. 16) is $13,690.92. The total profits for the year 1883 (see Ques. No. 17), after bringing all doubtful assets down to their actual value, are $15,213.26. Thus the total profits, at what may be called "hard pan", available for dividends December 31st. 1883, are $28,894.21.

If we should pay a 6 per cent dividend it will require, on $735,200. the sum of $44,112. of this amount the sum of $21,162. would be payable to the cash capital, and $22,950. to the stock of the Light Co. But if the Light

[ENCLOSURE]

stock of the Light Co. But if the Light Co. would accept as payment on account of its dividend, its share of the losses above set forth (see Ques. No. 18) viz:, $17,076.16, the actual cash required for its dividend, would be $5,273.84. In this way the total amount of cash required for 6 per cent dividend would be $26,435.84, which would leave a surplus of profit on hand after paying dividends, of $2,456.37.

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(20) Can the expenses of the Isolated Co. be reduced next year?

ANSWER. Judging from the present, it is not probable that the expenses can be reduced materially except in the New England Department, where they are now unusually large for the amount of business done. That matter is now having attention. For certain reasons it is an exceedingly difficult problem to solve, but the result ought to be that the expenses of that Department will be reduced possibly $10,000., per annum, thereby reducing the gross annual expenses of the business an equal amount.

The vacancy created by Mr Moore's resignation has not yet been filled. Accordingly his salary, which was $6,000. a year, together with a percentage on sales amounting to say $3,000. additional, is not now an expense. My judgment is that the business imperatively requires a first class man to take Mr Moore's place, and that the sooner he is selected the better. Should this be done the expenses of the headquarter office at New York City

[ENCLOSURE]

will not be materially reduced the coming year.

President.

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
Paris 1881
GRAND DIPLOME D'HONNEUR

ADRESSE TÉLÉGRAPHIQUE
EDISON, PARIS

Paris, le 21 Janvier 1884

64, Avenue de l'Opéra

Monsieur Charles Batchelor

Conformément aux arrangements intervenus entre nous, nous avons l'honneur de vous confirmer que, dans le cas où la fusion actuellement projetée des trois Sociétés Edison se réaliserait à bref délai, les dites Sociétés sont d'accord pour accepter l'offre que vous avez bien voulu faire de vous consacrer, jusqu'à la fin du mois de Juillet prochain, à l'amélioration du matériel tel qu'il est actuellement fabriqué et aux mesures nécessaires à prendre en vue de l'établissement de la Station Centrale de la Rue Basse du Rempart, à cet effet, vous feriez aussi conjointement aux frais de la Société un voyage à New-York, et une somme de deux mille francs vous serait allouée mensuellement, à titre de traitement.

Nous prenons également bonne note de ce que vous voulez bien faire au sujet du temps plus long pendant lequel vous pourriez rester avec nous si nos affaires personnelles vous le permettaient et nous vous en remercions.

Veuillez agréer, Monsieur, l'assurance de notre haute considération.

SOCIÉTÉ ÉLECTRIQUE EDISON

(Louis Rau) ADMINISTRATEUR DÉLÉGUÉ

600 Jan 29. 1884

My dear Edison,

I confirm my cable of this morning to you as follows:— "Knowside Newyork German decision makes us stronger my opinion you ought enforce advance royalty." Of course you have seen the joint cable sent by Bailey and myself last night as follows:— "Thyrecky Newyork ready sign fusion contracts conditions identical letter December 30th except light company guarantees [illegible] during three years Porges refuses absolutely before formation company engagement advance or loan rayt considers loan easy afterwards answer quick whether accept Bailey Batchelor." This question of the 200,000 as an advance royalty I have frequently discussed with Porges and although he never refused point blank to make it he always said he did not see how it could be done. At a meeting that I had with him on Sunday at his house he told me that Bailey had after borrowing from everybody that he knew come to him now and demanded $4000 intimating that if he did not get it he should be obliged to sell the shares he holds to sit on the board of the Electrique and resign his position. He said now that he

was thoroughly disgusted that the Light Company should
keep a man as their agent who was continually borrowing
money from the persons who were through him negotiating
as it were against the Light Co. He says now I give
you as a final word:- ("I will not make any advance
at present on the Founders shares; when they have
an actual value I will loan money £20,000 to
or £30,000 on the deposit of 4500 shares, his loan
for a certain time; I do not know anything about
an advanced royalty, the only way to get money
is to make a loan and if you ever only do so when
the shares have an actual value; I believe they
will have that value when this company is formed")
Now another thing he says:- (If the Light company
appoint their members for the board and they are
such men that I am not ashamed to sit with I
will do whatever I can to put them there — I
will allow Mr Bailey to sit on the board of directors
because I do not want him to work against the
Company; but I will not allow him to be the
"Administration delegue" nor sit on the board of
"Committee of direction" under any consideration
whatever; and if the Light Co enforces this, I will
retire from the thing altogether with my friends.
I tell you further that if the Light Co does not
ratify this present arrangement It will be
just the same as regards Mr Bailey he cannot
be "administration delegue" longer than April 30th
of this year")
I told Mr Jones I would get him an answer but

3

he must be prepared to receive a refusal as the Light Co were giving up everything that was vital to their interests and the sum of money they required to put them in a position to wait for the development was so ridiculously small that I was ashamed to make them that we could not get in.

Forges acknowledges that our position is now very strong owing to the German decision and he says he knows the Austrian decision will be the same; they in the office did not want to telegraph the news to you for fear the Light Co demands might be offer but I sent you a private one on it — Now my private opinion is that you would have got all you wanted if Bailey had not borrowed money from all these fellows, and Bailey cannot refuse now to advise the pushing of it through because he owes so much to them — In the meantime here is not one of them who can take hold of the thing and push Forges on one side and they hold out promises to Bailey of future position (in order to have the ratification of the Light Co) which they know will never be realised — My opinion also is that you will not suffer very much if this particular project does not go through as the successes in America & the patent decisions here will force the thing

Truly yours
Batchelor

30 Janvier 1885.

Cité

Monsieur L'Hôte
7 rue Margfoy
Paris

Dans le courant d'Août dr vous m'avez adressé un échantillon de charbons pour piles pour lesquels vous m'avez fait le prix de 200 francs par mille pièces, escompte d'habitude.
Le prix que vous avez fixé a été trouvé trop élevé par mes amis & je viens en conséquence vous prier de me faire connaître votre tout dernier prix pour une commande de 500 de pièces livrées contre espèces, à Paris pour expédition à l'Etranger & par mitié, bien emballées

Dans l'attente de vous lire je vous présente, Monsieur, mes civilités distinguées

Chas Batchelor

Jan. 31st 1884

603

Samuel Sunel

66 5th Avenue
New York.

My dear Sunel,

You will have read my letter to Edi[illegible] of a few days ago — Enclosed please find two cable[illegible]

Jan 27.	16 words	$40.00	=	$7.71
" 28	14 "	35.00	=	6.76
				$14.47

The first I sent because there was a desire to not give [illegible] information over there but the "Light Co" should be [illegible] terms and the second is private and could not be paid [illegible] our companies. If the European Co will pay them [illegible] me credit for same and oblige

Yours very truly
Chas Batchelor

2 enclosures.

Jan. 31 1884

602

Major Eaton:
66 5th Avenue
New York

My dear Major,

Enclosed you will find

1st a declaration of M. Leon that he has nothing to reclaim from either Mr Edison or the Light Co. dated 1st November 1883.

2nd A receipt from Mr. Castelbolognesi for (70) seventy 'Parts of founder' of the Compagnie Continentale Edison (No. 5175–5244) inc – This Mr Castelbolognesi is certified to by Mr Bailey as the person to whom it was intended to deliver them – This closes the 'Parts of founder' business and I have now carried out all your instructions relating thereto –

Very respectfully yours
Chas Batchelor

2. Inclosures.

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Feb 7 1884

M. A. L'Hôte

7 Rue Margfoy 7
Paris

Monsieur,

J'ai retrouvé les mesures de les charbons, ils sont celles-ci :-

Longeur 128 m m (cent vingt huit)
Largeur 038 m m (trente huit
Epaisseur 006 m m (six)

Je vous serai donc obligé de vouloir bien me donner un prix pour (5000) cinq mille et le date de livraison

Veuillez, agréez, Monsieur mes civilités empressées

Chas Batchelor

Machines Edison.

Prix du matériel moteur pour les différents types.

Cas d'un moteur à gaz.

Matériel moteur	Installation de :									
	17 lampes à 16	25 lampes à 16	50 lampes à 16	60 lampes à 16	100 lampes à 16	120 lampes à 16	150 lampes à 16	200 lampes à 16	250 lampes à 16	300 lampes à 16
	4 chevaux		8 chevaux		16 chevaux		20 ch.	25 ch.	40 chevaux	
Moteur	4000		7000		12500		14000	15000	19000	
Fondations	70		90		100		120	150	200	
Tuyauterie	300		350		400		450	500	750	
Transmission et fond.ons	500		680		800		1200	1500	2000	
Courroies	150		250		350		500	650	800	
Montage	100		150		150		200	300	400	
Totaux	5.120 f		8.520 f		14.300 f		16470	18100	23150	
Prix par lampe	301,176	204,80	170,40	142,..	143,.	119,166	109,80	90,50	92,60	77,166

Bory, le 13 Février 1884.

608

Paris Feb. 16 1884

Monsieur,

Veuillez faire et emballer pour être expediés à l'etranger (5000) cinq milles charbons des dimensions suivantes

longeur 128 m.m.
largeur 038 m m
Epaisseur 006 m m

Il est bien entendu que le prix de ces charbons n'excedera pas (200) deux cents francs par (1000) mille y compris l'emballage et la livraison en gare, avec un escompte de 3% payment au comptant et qu'ils seront de première qualité

Agreez monsieur mes sincère salutations

Chas Batchelor

33 Ave de l'Opera

M. L. Hôte
7 Rue Margfoy 7
Paris

Feb. 16 1884

Gentlemen,

Having lost the dimensions of L'Hôte not being able to remember them I had to cable you for them, and acknowledge your cable answer as follows:- "Five by three halves by one quarter inches" — Also acknowledge receipt of your letter of Jan 25th 1884. I have ordered the 5000 carbons 128 m m long 38 m m wide & 6 m m thick which corresponds to your telegram sizes. ~~I have tried my best to get you a~~ lower price than that at first quoted but have been unsuccessful although I told L'Hôte that you certainly would not pay that price for the next order — I succeeded in making him take the order packed and delivered in Paris so that their cost will be 200fr per 1000 3% off for cash — He wanted 2 months to make them but I have got him to ship 2000 in two weeks from now which will be the end of February. I will arrange to pay him here & we can settle after.

Very respectfully yours
Chas Batchelor

Messrs Bergman & Co
New York

Feb. 16 1884

My dear Edison.

I acknowledge your cable as follows:- 10 Feb. "Do you approve Baileys cable Eaton 7/4 words seventh and 18 words 8th." & I confirm mine of 18th as follows:- "Did approve but scheme buried". The fact was I meant to sign the 7/4 word cable with him but forgot all about it until your telegram came -

A better combination is now about to be made as will be seen from Baileys letter of today and I have joined him in the following cable "Ryrecky Newyork. Letter "February first received probably new persons strong business "men instead bankers will organize new company "authorize us quick on condition controlling influence "direction secured light company to withdraw demand "for cash otherwise lose opportunity organize founders "parts negotiable when company formed". I have also sent you the following:- "Eknoside Newyork: important "have favorable answer our cable ryrecky today enforcing cash payment will best combination"

It is my firm opinion now after many quarrels that we can only use this cash payment claim to give up on consideration of getting some guarantee that the companies will make money in the future

Very truly yours

Chas A Edison Esq
65 5th Avenue New York

Chas Batchelor

Essais de Durée

— 16 Février 1884 —

1° 10 lampes B 8 essayées à 8 bougies
2 brulées - 8 ont maintenant 207h22 Moyenne 182 heures

2° 10 lampes A 16 essayées à 16 bougies
2 brulées Moyenne 181 heures 19

3° 10 lampes A 32 essayées à 32 bougies
1 brulée Moyenne 195 heures

4° - 5 lampes A 32 4 fils de cuivre de platine — à 32 bougies
2 brulées 3 ont 113 heures 07 - Moyenne 79 heures 23

5° 6 lampes Maxim essayées à 16 bougies
6 ont 64 heures 55 - Moy
toutes ces lampes noircissent. —

6° 8 lampes Swan essayées à 16 bougies
6 brulées 3 ont 573h43 Moyenne 335h15

7° 5 lampes A 10 essayées à 8 bougies
3 brulées 2 ont 686h50 - Moyenne - 428h23.

8 1 lampe A 10 essayée à 10 bougies
1 a 126h45

Lampe Siemens. essayée à 16 bougie
à Duré 547 heures
Fils de platine du pôle + fondus — Charbon intact
Verre noir sur toute l'ampoule, et chargé d'un dépôt irisé
à l'endroit de rupture —

616 Feb 08. 1884

Mr A Edison Newyork.

My dear Edison,

I confirm following cables—

"Feb 16. Kyrecky Newyork Mentum advance capitalist
"Bills business and promoters not sufficient interest [illegible]
"obligations easily arranged afterwards German founders already
"hundred bid most urgently recommend authorize today sign
"without money condition will sign option tomorrow every hour
"delay dangerous if gets wind so trusted Batchelor Bailey"
also Feb 16:— "Ekeroide Newyork party entering good as Phelps
"Lodge thinks it excellent arrangement"
also Feb 07:— "Kyrecky Newyork articles association new
"company identical old except changes notice like Dec 29
"and others assuming you control added since contract for option
"identical that proposed bank centre Bullet our lawyer
"lowery knows him cannot sign ad referendum must sign
"tomorrow or break authorize name Edison director answer
"Batchelor Bailey."

I also acknowledge receipt of the following from Newyork:—
"16 Feb. 1884 Ekeroide Paris of withdraw each [illegible]
"what terms will promoters advance two hundred thousand on [illegible]
"portion our founders Edison Caton"
17 Feb. 1884 "Ekeroide [illegible] Paris waive money

"sign option subject approval formal contract meeting
"stockholders when contract received Edison Telm."

I shall probably get you off another letter today sending you a complete history of the affair with a copy of everything that has passed etc. The man who takes hold instead of Forges is ordinary Secretion exceedingly rich and has made all this money in industrial affairs; one of his companies is the largest brass & copper company in France if not in Europe. From all appearances we shall be assured of having our light pushed forward with all the vigor possible and with such a man we have the best guarantee that our shares will be worth something in the future.

Very truly Yours
Chas Batchelor

660 Feb 20 1884

My dear Edison,

I confirm our cable to Eaton of 19th Feb. as follows:- "Kyrecky Newyork think you mistake no new company formed simply fusion others with continental which continues owner of patents and takes whole business nothing except option to sign now or hereafter everything else embodied present statutes continentale entirely simple matter Batchelor Bailey" About the same time as ~~you~~ we were making this we were sending the following:- "Eknoside Paris doubtless stockholders will approve meeting callable ten days notice shall we call use Edison directors" Edison Eaton." Feb 19 1884 — the follow-

I acknowledge receipt at same time as above of the following:- Feb 19 1884 "Eknoside paris why not make Hayes director Edison"

I confirm our cable this morning as follows:-

"Kyrecky newyork authorize sign on last night cable explaining title patents not changed have been capitalist clear headed practical abundance money will take personally direction business getting him biggest thing since light came Europe says ready sign Batchelor Bailey."

It seems to me that we have unconsciously misled

you as regards the fusion for in some cables we have spoken of the "New company" whereas it is nothing but a fusion of the Societe Electrique and Societe Industrielle into the Compagnie Continentale which continues as before except that it raises its capital to 10,000,000 Fcs & does the business of all three companies.

We had a long interview with Secretan yesterday and were pleased with his straightforward, business-like, goahead qualities, impressions at first sight which I hope and believe will be corroborated by a longer acquaintance — I remember once about a year and half ago he came to Ivry and I took him round and explained the system at the same time impressing on his mind that he could make a great deal of money by taking all our copper work at reasonable prices. I did not know at that time that he was so rich a man, I simply thought he was one of the directors or perhaps the president of the copper company that I was trying to get my copper from.

All these cables that we have sent of course are paid here by the company although they as yet do not know their contents.

Yours Batch.

Mr A. Edison
65 6th Avenue
New York.

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SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs.

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique:
EDISON, PARIS.

Not exactly same

Paris, le _____ 188

624

33, Avenue de l'Opéra.

Feb. 21st 1884

My dear Upton,

Yours of Feb 5 to hand —

The new negotiations now going on will be much better for the European Co than the former ones. Whereas we had to pay back under old arrangements 2,000,000 to the Stockholders ~~before getting anything in the old arrangement~~ after which we got 80% of the profits; we now have nothing to pay back, and still further the founders shares get a royalty of 25 centimes per lamp used or sold whether Edison or anyone does; this 25 centimes comes out as an expense like paying a bill thus practically making our interest preferred instead of deferred; besides this ~~which~~ the founders shares take 40% of the profits after legal reserve, shareholders 6%, and board of directors — The Societe Electrique & Societe Industrielle are fused into the Continentale company whose capital will be raised to £70,000,000 & they receive fully paid up shares ~~for their share~~ in exchange for their shares; £6,500,000 in cash will be brought in by the new syndicate — the founders shares of the Societe Electrique & Societe Industrielle

will be annulled, thus leaving the founders shares of the Compagnie Continentale 8000 in number the only ones — these will be divided as follows:—

Edison Electric Light C. of Europe	4500	or 9/16
Old Syndicate	1070	"
New Syndicate	2000	
Puskas & Bailey & others (received at first for Commissions)	430	
	8000	

For this 6,500,000 Fr we shall get a new man a Mr Secretan a thoroughly business, go ahead, man and enormously rich thus throwing Porges out who has been a millstone round our necks ever since I came here — (ask Insul what he thinks of Porges)

3,000,000 Frs of this will be spent in a Central Station in Paris the devis of which I have got out a long time ago & am coming over & New York to go over it with S.A.E. shortly

In doing away with the Societe Electrique it allows us to sell at much lower prices so that we can get everything in the isolated line in Europe — If we had had men as experienced as we have now we should have made a very large amount of money as it is we have made a good profit on last december's sheets

We will suppose that the company made no profit next year and only sold 200000 lamps

COMPAGNIE UNIVERSELLE
DU
CANAL INTEROCÉANIQUE
46, Rue Caumartin

N° 1 A J K H

Les lettres doivent être adressées à M. le Président-Directeur de la Compagnie

Objet de la Lettre
Actions

Renseignements

Paris le 27 Février 1884

Monsieur,

En réponse à votre lettre du 23 courant, j'ai l'honneur de vous informer qu'il n'a été appelé que deux versements de 125f. chacun sur les actions de notre Compagnie; vous n'avez, par conséquent, rien à verser sur vos titres libérés de 250f.

La date du troisième versement n'est pas fixée, mais aux termes de l'art. 9 des statuts, vous en serez informé au moyen d'annonces publiées trois mois à l'avance dans un des journaux de Paris désignés pour recevoir les annonces légales et dans les journaux étrangers désignés par le Conseil d'Administration.

En vertu de la décision de l'Assemblée Générale des Actionnaires du 29 Juin 1882, les certificats provisoires et nominatifs d'actions dont vous êtes titulaire doivent être échangés

Monsieur Ratchler, 16 rue de la Bienfaisance (Paris)

contre des titres définitifs soit au porteur, soit au nominatif ; cette opération est gratuite, et je vous envoie, à cet effet, un bordereau que je vous prie de vouloir bien me retourner régulièrement rempli et signé, avec vos titres à échanger. Pour la mise au porteur, la signature doit être certifiée par un officier ministériel, agent de change, notaire etc ....

Dans les dix jours de la réception de ces pièces, je vous adresserai les titres définitifs et le montant des coupons échus.

Veuille agréer, Monsieur, l'assurance de ma considération la plus distinguée.

S. Le Président-Directeur,

M. Fortane

Feb. 28th 1884

Thos A Edison &

My dear Edison. New York

On the 25th I received the following cable from Stockholm:- "Batchelor Paris Swedish patent office notifies Edisons light patents voided. doubtful reasons? protests? Olan" I do not know who "Olan" is but I immediately cabled you as follows:- "Ekonomiske Newyork just rec'd telegram Stockholm saying patents voided can I do anything" or words to that effect.

I also immediately wrote to Brewer and Jennson of London but they sent me word that they had nothing to do with the patents since 1882.

I am now trying to find out who this Olan is as I have expected a letter on the subject but have as yet received none

Yours truly

'Batchelor'

I enclose letter of Brewer & Jennson of Feb 27 1884

C.B.

COMPAGNIE UNIVERSELLE
DU
CANAL INTEROCÉANIQUE
46, Rue Caumartin

N° 18066

Les lettres doivent être adressées à M. le Président-Directeur de la Compagnie

Objet de la Lettre

Accusé de réception

Paris le 3 Mars 1884

Monsieur,

J'ai l'honneur de vous accuser réception des cinq certificats provisoires et nominatifs d'actions que vous m'avez adressés pour être échangés contre un nouveau certificat nominatif.

Le titre définitif vous sera adressé le 12 Mars

Veuillez agréer, Monsieur, l'assurance de ma considération la plus distinguée.

Le Président Directeur,

M. Lesseps

P.S. Prière d'indiquer l'adresse qui doit être portée sur le nouveau certificat.

Monsieur Rotschild, 16 rue de la Bienfaisance, Paris

The Edison Electric Light Company
of Europe Limited

65 Fifth Avenue New York March 11th 1884.

Charles Batchelor, Esq

Dear Sir:

Enclosed I beg to hand you a copy of the Report which I prepared for the meeting of Stockholders on the 7th inst. I think you will be interested in reading it, as it sets forth the present position of our Company in full. I regret that it is not more encouraging, but hope the new arrangement will prove to be the turning point to a better state of affairs.

I presume you will have learned before this that our Stockholders confirmed the action of the Directors in authorizing you and Mr. Bailey to sign the option. I wrote Mr. Bailey to that effect immediately after the meeting.

Very truly yours

W Lane

Second Vice President.

COMPAGNIE UNIVERSELLE
DU
CANAL INTEROCÉANIQUE
46, Rue Caumartin

N° 193/4

Les lettres doivent être adressées à M. le Président-Directeur de la Compagnie

Objet de la Lettre
Envoi
de
Titres définitifs

Paris le 12 Mars 1884

Monsieur,

J'ai l'honneur de vous adresser ci-joint, un certificat nominatif, N° 16709, de 5 actions, en échange des certificats provisoires et nominatifs d'actions que vous m'avez envoyés. J'ai encaissé pour votre compte les coupons N° 1, 3, 4, 5 et 6 qui n'avaient pas été détachés et j'ai prélevé sur le montant les frais à votre charge, dont détail ci-après.

Crédit

5	Coupons N° 1 à 2 f 96.5	= 14 f 825	
5	Coupons N° 3 à 5 f 91	= 29. 55	
5	" N° 4 à 5 f 91.5	= 29. 575	133 f 05
5	" N° 5 à 5 f 91	= 29. 55	
5	" N° 6 à 5 f 91	= 29. 55	

Débit

Frais de manuel	0. 50	
Timbre quittance	0. 10	1 f 25
Affranchissement	0. 65	

Je vous envoie la différence, soit 131 f 80.
Vous voudrez bien m'accuser réception du présent envoi.

Veuillez agréer, Monsieur, l'assurance de ma considération la plus distinguée.

P. Le Président-Directeur.

V. de Lesseps

Monsieur Balcheler, à Paris, 16 rue de la Bienfaisance,

5.20 / 131.50 / 1.24 / 2.60 / 1.50 / 1.68 / 2.40 / 2.70 / 2.50 / 2.50

CABINET DE M. CH. THIRION, INGÉNIEUR CIVIL
Maison spéciale pour la garantie de la Propriété industrielle
En France et à l'Étranger (fondée en 1852).
Bureaux : 95, Boulevard Beaumarchais, à PARIS

OBTENTION DES BREVETS D'INVENTION
EN FRANCE ET A L'ÉTRANGER

Dépôt des Marques, Dessins
et Modèles de fabrique.

RECHERCHE DES ANTÉRIORITÉS
Copies et analyses de brevets en vigueur et déchus

CONSULTATIONS
EN MATIÈRE DE BREVETABILITÉ, DE NULLITÉ
DE DÉCHÉANCE, ETC.

CESSION DES BREVETS
Rédaction des actes de cession ou de licence

Direction des procès en contrefaçon
RAISIER — MÉMOIRES TECHNIQUES ET LÉGAUX

TRAVAUX TECHNIQUES, ETC., ETC.

PUBLICATIONS
De M. Ch. THIRION

TABLEAU SYNOPTIQUE & COMPARATIF
DES LÉGISLATIONS FRANÇAISE ET ÉTRANGÈRES
en matière de Brevets d'Invention
En Album, prix cartonné, franco : 10 fr.

LE CARNET DE L'INVENTEUR ET DU BREVETÉ
Conseils pratiques aux Inventeurs
Prix cartonné, franco : 3 fr.

LES DESSINS & MODÈLES DE FABRIQUE
PRÉCIS DES LÉGISLATIONS — Prix franco : 3 fr.

LES MARQUES DE FABRIQUE
PRÉCIS DES LÉGISLATIONS — Prix franco : 1 fr. 50

RAPPORT SUR LE CONGRÈS INTERNATIONAL
des Brevets d'Invention tenu à Vienne en 1873
Prix franco : 5 fr.

COMPTE RENDU ANALYTIQUE
DU CONGRÈS INTERNATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE TENU A PARIS EN 1878
Prix franco : 6 fr.

LISTES MENSUELLES DES BREVETS D'INVENTION
DIVISÉES EN 31 CLASSES
correspondant chacune à une grande division de l'Industrie
Abonnement | Une classe, par mois. . . . 5 fr. »
| Chaque classe suivante. . . » 50

EXÉCUTION DE DESSINS INDUSTRIELS
Aquarelles Industrielles et Lavis
Gravures sur bois, sur zinc, sur pierre
Photogravure — Autographie — Lithographie
Dessins de construction

PARIS. IMP. CH. BAUD

Paris, le 22 Mars 1884

Monsieur Oscar Patchelot
16, Rue de la Bienfaisance
Paris

J'ai l'honneur de vous accuser réception de votre Mémoire de ce jour, et de vous informer que je serai à votre disposition à mes bureaux lundi ou mardi de 10 à midi pour vous entretenir au sujet des deux brevets français dont vous me parlez.

Pouilly sur Loire, Monsieur,
mon adresse bien empressée.

Ch. Thirion
Ing.

Adresse télégraphique : **THIRION, BREVETS, PARIS.**

$$\frac{5 \cdot 4}{5} = \frac{10 \cdot 8}{20}$$

$$\frac{20}{10} \quad \frac{8}{10} = 1'$$

$$\frac{20}{5} \cdot \frac{5 \cdot 4}{10 \cdot 8} = \frac{5}{20} =$$

$$20 \overline{)50} \,|\, 0.2$$

$$50 / \frac{2.5}{5.0} = 0.25$$

$$\frac{\partial L'}{K} = \frac{EI}{N} = \frac{5 \cdot 4}{5} = \frac{10 \cdot 8}{20}$$

$$\frac{\partial L}{EI} = \frac{M}{K} = \frac{5 \cdot 4}{10 \cdot 8} = \frac{5}{20}$$

$$\frac{\cancel{\partial L}}{\partial} =$$

$$L = \left(\frac{\partial L}{N} \quad \frac{E}{\varepsilon}\right) 1 = \left(\frac{5}{20} \quad \frac{10}{5}\right) 8 = \frac{50}{10} = \frac{400}{100} = 4$$

Шкаф №1 Ор
Расчёт рамы

			0.1
			0.2
			0.3
			0.4
			0.5
			0.6
			0.7
			0.8
			0.9
			1.0
			1.1
			1.2
			1.3
			1.4
			1.5
			1.6
			1.7
			1.8
			1.9
			2.0

15 Rue d'Argenteuil
Paris Mch 24 /4

M. Abritard.
18 Rue Montmartre
Paris

My dear Sir

In order to exploit a French patent for 'cables', I wish to have about a hundred metres of a special kind with 4 conductors made — Can you make this for me? and if so when can I see you to explain the matter. Please drop me a postal card and oblige

Yours very truly
Chas Batchelor

Paris – March 27. 1884

My dear Sir,

Your letter of Feb 29th 1884 has been forwarded to me by Mr Handford – I find the French patents are

No 143350 June 13. 1881 Name of Gouvand
No 147328 Feb 11 1882 " " Delaney

these correspond exactly to the subject matter of English patents 2532 1881 and 333 of 1882

For working a small length similar to Fig 1 English patent 333, take a piece about 30 metres long similar to instructions given by you letter which will be put up permanently at our factory; this will be sufficient for working and will be the means of determining the price per kilometre if you should desire afterwards to make a trial on the French lines with a view to selling the patent or getting a royalty on it

Very truly Yours
Chas Batchelor

I cannot leave here till middle of April as I must go with our new capitalist to the Central Station at Milan.

Yours B.

Edt Johnson Esq
85 5th Avenue
New York

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Grand Diplôme d'honneur

PARIS 1881

Ivry-sur-Seine, le 28 Mars 1884

5, RUE DU PARC.

Monsieur Ch. Batchelor
Paris

J'ai bien reçu votre lettre et l'extrait du procédé d'étalonnage américain.

Je me permettrai de vous soumettre les observations suivantes.

La base du procédé est la détermination de la force e.m. à l'aide d'une expérience de calorimétrie.

Vous savez qu'il faut alors faire intervenir l'équivalent mécanique de la chaleur dans le calcul.

Or le professeur Rowland, ayant fait des expériences qui étaient précisement destinées à obtenir par cette méthode du calorimètre la valeur de cet équivalent, je crois qu'on doit s'en rapporter à ces résultats. Le prof. Rowland a malheureusement trouvé des écarts très-notables entre ses

diverses détermination : Je n'ai pas les chiffres exacts ici : mais je crois me rappeler que les écarts extrêmes étaient voisins de 416 d'une part et 432 de l'autre. —

Il en résulte que les variations possibles sont d'au moins 4 %, dans les meilleures conditions d'expérences.

Pour le moment, notre étalonnage est d'accord avec celui de New York, et tous nos efforts tendent à le maintenir constant.

J'aurais, pour ma part, beaucoup plus de confiance dans les éléments étalon de Latimer Clark, dont nous pourrions acheter 5 ou 6 types en Angleterre.

J'en ai causé, il y a quelques jours, avec M. Potier, professeur à l'Ecole Polytechnique, qui m'a absolument confirmé dans mon idée ; il pense que la méthode du calorimètre est mauvaise, à cause du trop grand nombre de coefficients qui entrent dans le calcul. Il a une expérience personnelle des éléments Latimer Clark, qu'il considère comme très-bons.

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Grand Diplôme d'Honneur

PARIS 1881

IVRY-sur-Seine, 5, RUE DU PARC.

le 28 Mars 81

3/

J'ai installé sur la ligne un des électrodynamomètres que nous avions ici. L'instrument est lent, et tellement mobile qu'il ne s'arrête jamais. Toutefois, en lui mettant un amortisseur, nous arriverons à l'améliorer.

Quant aux dispositions de résistances employées à Nevart, et relatées dans l'Etalonnage, c'est une disposition qui est aussi bonne qu'une autre : il y en a un grand nombre du même genre, qu'on peut adopter indifféremment et obtenir la même precision.

Neuilly agréez, Messieurs nos bien sincères civilités.

SOCIÉTÉ Industr. et Com. de EDISON

(Picou)

325

Dr. Chas. Batchelor Esqr. and Mrs. Rosamund Batchelor in account Current with Drexel Harjes & Co. up to March 31st 1884 — Cr.

1884						1884					
Jan 7	5	3 Our Remittance under registered cover	f	2000		Jan 7	1	By Balance as per statement rendered	f	10482	20
	"	Insurance on above Remittance		2	"		14	" Cash deposit		4000	"
	17	" Check No 1882 [illegible] Soc. Electrique Edison		366	05		16	" " "		921	"
Feb 7	4	" " " " Self		6000	"	March	4	" " "		1152	"
March	31	" Balance carried down		10087	10		21	" " "		1164	55
							31	" Interest 1½ %		35	40
			f	18455	15				f	18455	15
						March	31	By Balance to your credit	f	10087	10

E. & O. E.
Paris March 31st 1884

17 avril 4

Monsieur O. Chirion
95, Boulevard Beaumarchais
Paris.

Monsieur,

J'ai l'honneur de vous envoyer ci-inclus, copie d'une lettre que j'ai adressée, en date du 29 Mars, à la maison Bonis pour lui demander quelques échantillons des câbles indiqués dans les brevets français de Gouraud N° 143,380 (13 Juin 1881) et de Delauney N° 147,388 (11 Février 1882), ainsi que 50 mètres de câble construit suivant les mêmes principes et destiné à servir de ligne définitive.

Je vous envoie également la réponse de la maison Bonis; vous verrez qu'il a été assez long pour monter l'outillage nécessaire à cette fabrication, mais qu'on est à même maintenant d'en livrer dans un bref délai.

J'ai reçu quelques échantillons que j'ai essayés et qui me paraissent très bons; je vous en envoie un spécimen.

La ligne définitive sera posée dans une huitaine de jours et je vous aviserai de son fonctionnement.

Agréez, Monsieur l'assurance de mes sentiments distingués,

Ch^s Batchelor

[ENCLOSURE]

Paris 29 Mars 1884

Monsieur Abollard
Maison Vve Bonis
18, Rue Montmartre
Paris

Veuillez me faire de suite quelques morceaux de ce câble plat de 6 brins recouvert en plomb ainsi qu'il est décrit dans les brevets français No 143.380 (Juin 13 1881) & No 147398 (11 Fév. 1882); & 50 mètres du câble qui couvre les revendications les plus importantes de ces brevets ainsi qu'il a été convenu verbalement entre nous. Je me propose d'essayer ces conducteurs sous terre. Ci-joint, je vous remets les dessins des brevets anglais correspondants que vous comprendrez facilement par les explications verbales que je vous ai données.

Recevez, Monsieur mes salutations empressées.

Paris 17 avril 1884

Monsieur Ch. Batchelor
33, Avenue de l'Opéra
Paris.

Monsieur

J'ai bien reçu votre honorée du 29 Mars contenant commande de 50 m. câble sous plomb suivant les dessins que vous m'avez donnés. J'ai eu beaucoup de difficultés pour arriver à fabriquer pratiquement ces échantillons, mais tout cela est maintenant surmonté et je peux vous fabriquer ces cinquante mètres ainsi que les autres commandes déjà reçues

Je vous prie d'agréer
Monsieur, mes sincères salutations.

pp.on Bouis
Signé Aboilard.

Mme BONIS

18, RUE MONTMARTRE, 18

Usine à Vapeur Rue Pelleport, 116

PARIS

FABRIQUE SPÉCIALE DE FILS

APPAREILS ÉLECTRIQUES

GUTTA-PERCHA

Fils & Cables pour Lumière Électrique

CABLES SOUTERRAINS

Cordons Téléphoniques

Cables Téléphones

CORDONS SOUPLES

pour Appareils Médicaux.

Fils de Gutta-Percha & Enduits

POUR

SONNERIES ÉLECTRIQUES

ADRESSE À L'ÉCRIT.

Paris le 25 Av. 1887

Monsieur Ch. Batchelor
33 av. Opéra
G. V.

Monsieur,

Les 50 mètres de câbles commandés dans votre honorée du 29 Mars sont terminés. Je me tiens à votre disposition pour les essais que vous voudrez faire.

Veuillez me dire si je dois garder ce câble à l'usine ou bien rue Montmartre, en vue de votre visite.

Veuillez agréer Monsieur mes sincères salutations

p.p.on C. Bonis
A. Boitard

Copy.

Paris le 25 Avril 1884

Mme Bonis
18 Rue Montmartre 18
Paris

M. Ch Batchelor
Av. de l'Opera

Monsieur,

Le cable (50 mètres) contre l'induction que vous m'avez commandé est maintenant terminé et mis en place. D'après les essais fait par moi-même il n'y a pas d'induction entre les fils. Veuillez je vous prie venir vous en assurer vous-même je serai tout à votre disposition. Ci-inclus la facture pour le fil et la pose

Veuillez agréer
Monsieur mes sincère salutations

pp. C. Bonis
C. Aboilard

(Original held by Thiroin of Paris)

Société Industrielle et Commerciale Edison

Société Anonyme, Capital : 1.500,000 Francs

Exposition Internationale d'Electricité

Grand Diplôme d'honneur

Paris, 1881

Ivry-sur-Seine, le 28 avril 84

5, Rue du Parc.

Force électromotrice des lampes expédiées le 28 avril 84 à M. T. A. Edison.

Nos	A16 Inclinaisons de la lampe sur la ligne du photomètre 45°	A16 225°		A10 Inclinaisons de la lampe sur la ligne du photomètre 45°	A10 225°
1	100 volts 5	100 volts 5	26	104	104
2	94, 5	94, 5	27	109, 5	109, 5
3	97, 5	97, 5	28	109	109, 5
4	109, 5	110	29	105	105, 5
5	99, 5	99	30	106, 5	105, 5
6	98	98	31	87	88
7	107	107, 5	32	108	108, 5
8	97	97	33	106, 5	106, 5
9	99, 5	99, 5	34	109	109, 5
10	98, 5	98, 5	35	97	97
11	96, 5	97	36	107, 5	107, 5
12	98	98	37	109, 5	109, 5
13	98, 5	98, 5	38	107	107
14	103	103, 5	39	110	110
15	103, 5	104	40	105, 5	106
16	95	96	41	108, 5	109, 5
17	105	104, 5	42	107	107
18	101, 5	102	43	106, 5	107
19	103, 5	103, 5	44	108, 5	107, 5
20	101, 5	101, 5	45	109	110
21	92, 5	93, 5	46	109	109
22	109, 5	110	47	109	109
23	108	108	48	103	104
24	105	105, 5	49	109, 3	109, 3
25	105	105, 5	50	105, 5	105

[1884?]

Etat des Lampes en Magasin au Lundi le 28. Avril 1884

																																												Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40				
Lampes de 1 bougie																																												
d° 4 d°																																												
d° 8 d°																																												
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80				
Lampes B°						7	45	203	470	723	759	1065	485	382	365	864	688	661	333	273	150	120	96	38	42																			7769 B°
d° B° à cadran	1	1	7	11	13	26	30	36	33	42	35	35	23	13	7	9	6	3	6	3	2		4	2	3																			351 Cadran
d° B 16		4	17	45	215	437	735	1147	1223	1231	990	673	389	359	191	197	128	77	37	28	16	10	11	4	7																			8102 B 16
d° S 10																						7		2	6	4	5	2	2					18	16	12	12	10	9	2				108 S 10
	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	124	125	129	
Lampes A 10	1				3	7	31	64	22	135	375	206	390	357	529	433	411	385	194	28				35	80	155	16	18	27	199	333	448	351	335	357									5598 a 10
d° A à boule											1	2	3	9	19	11	19	34	26	36	1	2	1	6				24	20	22	7	3	4	1	2									243 Spirale
d° A 16	1	1		1	2	1	1	76	18	114	177	352	383	422	786	712	900	1071	1012	562	384	37	34	21	27	31	72	53	221	78	230	328	340	277	165									8790 a 16
d° A à cadran	2	2	2	8	8	17	19	11	13	36	36	28	31	27	26	33	31	33	23	9	7	18	16	13	7	2	3	11	5	4	8	3	2	2	4						2			510 Cadran
d° A 32		1					1		1	17	30	39	61	103	25	84	112	103	53	107	24	212	105	78	143	113	98	53	75	61	30	16	26	16	20									1877 a 32
d° A 32 à cadran																2	3	1	1	2	2	1			1	1	1	1		3														19 Cadran
d° A 50																						1	1	1	1	1	1	2					1							1				10 Bougies 50
d° A 100																										2							1		1		1	1		1	1	1	1	10 Bougies 100

Paris 1er Mai 1884

Compagnie Universelle du
Canal Interoceanique
Paris

Messieurs,

Conformément à votre lettre du 27 Février je vous envoie ci-inclus mes cinq certificats provisoires (122765 - 122769 inclus) pour les avoir échangés contre des titres définitifs et nominatifs

Agréez messieurs, l'assurance de ma considération la plus distinguée

[signature]

14 Rue de la Bienfaisance
Hotel Alexandra

Statement of
Chas. Batchelor Account
From Dec 10th 1883 to June 4th 1884

	Dec 10th	Statement Rendered		312293
	" 31st	Telephone Royalty	+	10000
1650	" 31st	To Cables		
	1884 Jan 30th	Telephone "	+	10000
1500	Jan 30th	To Safe Deposit Co		
2400	" 30th	" Insurance		
	" 31st	By Cables	+	1447
	Feb 25th	" Canadian Royalty	+	40000
	" 25th	" Telephone "	+	10000
10500	Mar 31st	To Mutual Life Ins Co		
	" 31st	By Telephone Roy	+	10000
	" 31st	To Amount Paid you		
80000		in Europe by Mr Merrill		
	Apr 30th	Telephone Royalty		10000
	May 31st	" "		10000
	" 31st	To 10% of Expenses of Mr Johnson Exhibiting Light in England in 1882		
13402				
10000	June 3rd	To Check		
294288		To Balance		
413740				413740
	June 3rd	Balance due you		$294288
July 1st		Tel Royalty		
11 10		June 30th		101
1452 00		Check July 3.		

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 2 Million de Francs.

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique :
EDISON, PARIS.

Paris, le 3 Juillet 1884

55, Avenue de l'Opéra,

Monsieur l'Administrateur

Conformément à la décision de notre Conseil d'Administration, nous avons l'honneur de vous informer que nous tenons à votre disposition la somme de

F. 750.—

que vous voudrez bien toucher à notre Caisse, cette somme, représente la valeur des jetons de présence vous revenant pour le premier semestre de cette année.

Agréez, Monsieur l'Administrateur, l'assurance de notre haute Considération

SOCIÉTÉ ÉLECTRIQUE EDISON

[signature]

ADMINISTRATEUR DÉLÉGUÉ

Monsieur Ch. Batchelor
16 Rue de la Bienfaisance
Paris

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
Paris 1881
GRAND DIPLOME D'HONNEUR

ADRESSE TÉLÉGRAPHIQUE
EDISON, PARIS

Paris, le 3 Juillet 1884

33, Avenue de l'Opéra

Monsieur l'Administrateur

Conformément à la décision de notre Conseil d'Administration, nous avons l'honneur de vous informer que nous tenons à votre disposition la somme de:

Fr. 833.75

que vous voudrez bien toucher à notre Caisse; cette somme, représente la valeur des jetons de présence vous revenant pour le premier semestre de cette année.

Agréez Monsieur l'Administrateur l'assurance de notre haute considération

COMPAGNIE CONTINENTALE EDISON

[signature]

ADMINISTRATEUR DÉLÉGUÉ

Monsieur Ch. Batchelor
16 Rue de la Bienfaisance
Paris

5666

New-York à 3 jours de vue

Paris le 29 Août 1884 B.P. Fr 1333.90

A trois jours de vue payez par cette 1ère de Change

du nécessaire fondé de moi-même la Somme

de Treize cent trente-sept francs 90/100

Valeur en compte que passerez en Compte suivant avis de

A Monsieur

Ch. Batchelor

à New-York

Edison Machine Works, 104 Goerck Street

PAID

C. L. P.

E 28-178.50T

payez à l'ordre de Mrs
J. Thuilier Lheureux & Cie
Valeur en compte
Paris, le 27 Août 1884
Edmond

payez à l'ordre du Crédit
Lyonnais, Agence de Paris
Valeur en compte
Paris, le 28 Août 1884 Thuilier Lheureux & Cie

PROTÊT SIMPLE
VALEZ À L'ORDRE DE
Morton Bliss & Cie
VALEUR EN COMPTE 29 AOUT 1884
CREDIT LYONNAIS
Par Procuration Spéciale

Pay Cheque to our order.
Morton Bliss & Co

Paris 26th Aug. 84

[illegible]

Dear Mr. Batchelor

I have been intending to write to you every day for at least seventeen weeks, and could never come to it something or other always being in the way. I trust yourself and family are all in good health. I was very sorry not to see Mr. Batchelor before her departure. I proposed paying her a visit when I suddenly heard that she was gone. Please make her my apology and present her my respectful compliments. I was very sorry to hear that you had given in your resignation but I must say I was more so for the company and myself than for you. I have followed your good example since I also have given more last month, and am going to have on the first of October. I have been offered a position in chief engineer of an electrical Business which by the by

1

has no relation whatever with electric light – My salary is to be more than double and after a year over three times the money which our company affords to pay me after three years, as I stated it in a letter to Forgis by which I expressed all the sorrow which fills my heart at leaving him –

My first hundred light dynamo turned out to give 110 volts at 1200 turns and heated up to 85° after ten hours running –

On the German company's suggestion our people thought it was too much, and I made a new one with 50% more section of wire which takes only 1000 turns – but it heats up just the same – I was very much astonished, and tried the machine without any current at all it heated up to 65° after a few hours running – I tried several armatures without any wire on and they did just the same – The 200 light and the 500 both

2

heat up very much – The 25 and 50 light dynamo only remain cool after a few hours running – We have tried to replace the iron plates which hold the discs with fiber plates, and we have had a good result – We are making now some more experiment and I shall let you know about it if we find anything good – –

Did you try your machines without current on the armature, and do they not heat?

I send you your notebook, with note on dynamos which you have left at the laboratory and which I believe you will be glad to have – I shall also send from the factory all particulars on our hundred light dynamo and on a new three hundred light which is now in hand –

Our compound dynamos work beautifully when the speed remains perfectly constant – which it never does –

Do you have many orders for compound machines in the State – It is here a perfect [illegible] – In some time we shall sell no other

The company's office are no more Avenue de l'opéra, but Rue Caumartin — The top floor of the house is prepared for lodging the director of the Central Station Rue Basse du Rempart —

I should like to know if that fellow has already got into the womb of his mother — and if he enjoys it —

In the meanwhile they keep on sending all sorts of people away — and the general tendency is to replace those who go away by young Lutherans of which Verres as a son of a clergyman seems to have a good stock —

They will go on in this way untill they have no money at all left and I hope as a shareholder that the business may fall at that time to a man even brighter than Chatard —

By the end of the year I shall probably have some shares to sell, can you tell me if and how they could be sold in New York? You would greatly oblige me —

My brother in law, whom you already know I believe is actually on board sailing towards New York, He is send by the paper "La Lumière Electrique" as a correspondent for making accounts of the Philadelphia exhibition — I have given him a word of introduction to you and would be very thankful if you would receive him favourably —

Hoping to hear from you soon and to receive good news

I remain

Yours very truly

Szarvady

2 Rue Meissonier —

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

SAMUEL INSULL,
SECRETARY.

EDISON MACHINE WORKS,
104 GOERCK STREET,

CABLE ADDRESS:
"EDISON NEW YORK."

New York, 29th August 1884.

Three Wire System.

The Three wire system, which was invented by Mr. Edison, has now been in use for over 2 years, & is employed in conjunction with our system in all our Central Station plants in this country, the names of which, with number of Lamps connected, are given below:-

Brockton Mass.	1,600	Lamps.
Bellefonte Pa.	800	Lamps.
Middletown Ohio.	500	"
Williamsport Pa.	3,200	"
Piqua Ohio,	1,000	"
Newburgh New York (underground)	1600	"
Tiffin Ohio,	1,000	"
Fall River, Mass.	1,600	"
Shrighton, Pa.	1,000	"
Mt. Carmel Pa.	500	"
Lawrence, Mass.	3,200	"
Shamokin, Pa.	1,600	"
Sunbury, Pa.	500	"

The above plants are all in active operation; there are many others which are contracted for & even being put up, which we do not mention.-

The Three wire system, as the name indicates, is composed of 3 wire,

- over -

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SAMUEL INSULL,
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104 GOERCK STREET,

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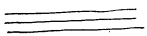
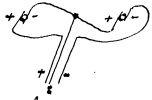
"EDISON NEW YORK."

New York, ...

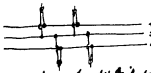


the positive, or upper, the negative or lower + the center or neutral or Compensating wire. - For the operation of this system, we need two Dynamos Connected in series as below :-



with wires connected as above. -

The lamps should be alternately connected between positive + neutral + negative + neutral wire -



+ great care should be exercised to distribute the lamps as equally as possible between the two sides of the system, in order to be kept it balanced, as nearly as can be. - When the system always perfectly balanced + all lamps turned off + on at once, it would be superfluous to connect the neutral wire to the Dynamos, as there wd. exist a permanent Electrical Equilibrium. - In one word, the neutral wire acts in our system, like a Safety Valve in a Boiler, + offers an outlet to the extra amount of Electricity when there is, when one or more lamps are put out on one side of the system. —

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PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

SAMUEL INSULL,
SECRETARY.

EDISON MACHINE WORKS.
104 GOERCK STREET,

CABLE ADDRESS:
"XYDSUN NEW YORK."

3.

New York, ...

Thence the facility for Regulating & Keeping balanced the 3 wire system, by means of automatic appliances, invented by Mr. Edison & placed in proper position & connected to the Conductors inside the Central Station.

The lamps should be connected between the wires as stated above for the following reason. - The Electro-Motive force of each of the Machines being 110 volts & they being connected in series, the difference of potential at the poles would be 220 volts; allowing

10% drop in Feeders;
3% " mains.
20% " House Wiring.

the difference of potential between the 2 outside wires in the circuit wd. be about 205 volts, which Electro Motive force would burn out the lamps, as they only require about 102 volts (such as we use for C.W. purposes) To obviate this difficulty we connect the lamps as shown above, the difference of potential at poles of lamps so connected being about 102 volts, which is the required E.M.F.

This arrangement causes 2 lamps to be in series between themselves, & consequently for the calculation of the size of the Conductors we can look upon this arrangement, as 2 lamps made in one, of the double resistance & in multiple arc across the 2 outside wires, which whilst allowing us according to known rules, to make the Conductors

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EDISON MACHINE WORKS,
104 GOERCK STREET,

CABLE ADDRESS:
"XYDSUN NEW YORK."

N.

New York, ...

four times as small as in the 2 wire system, still gives us perfect & individual control over all our lamps as heretofore. –

Let us consider the saving in weight of copper, which is gained by this system, over the old 2 wire system: –

Let us take the 2 wire system & suppose the wires necessary to carry a certain amount of current will weigh 1 lb each.

1 lb.
1 lb. –
1 lb. –

the total weight will be 1 lb. –

in the 3 wire system, the wires being 4 times smaller, we will have.

1 lb
1 lb
1 lb.

the total weight will be 3/4 lb.

& the saving will be, 1 lb − 3/4 lb = 1/4 lb = 63% in round figures – which saving can be still increased by taking the neutral wire 1/2 of the size of the other wires, as in practice we find by actual measurements, that the 3 sides of the system are nearly always balanced, especially in the residence portion of towns, & we shall then have a saving:

1 lb − 7/16 lb = 9/16 lb = 69% saved.

Above figures are rough figures.

By looking at the manner in which the conductors are connected to the dynamo, it will be seen, that only 1/2 both machines

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5

New York, ...

break down simultaneously, a town, or whatever may be the place to be lighted cannot be left in total darkness, as one Dynamo being connected to one side of the system & the other Dynamo to the other side of the system, should one break down, only every light would be extinguished & these alternate lights could at one be relighted by the movement of a switch, which would throw out of circuit the disabled machine, & throw in ~~circuit~~ 1/2 of the lights not burning on the perfect side of the 3 wire system, which would then temporarily become a 2 wire system, until the damage could be repaired. —

The Three wire system, may to a great extent, be looked upon as a Duplicate 2 wire system, with a saving of 63% - 69% in the Cost of the Conductors, which item is generally a great part in the Cost of a Central Station plant. —

H. [illegible]
New York, 20th August 1914.

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

SAMUEL INSULL,
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104 GOERCK STREET.

CABLE ADDRESS:
"XYDBUN NEW YORK."

6.

New York, ...

Feeders, Mains & Services.

The 3 wire system can be run both overhead & underground, the underground conductors being about 3 times as expensive as the overhead. Their cost however is compensated by the wear, as the underground system made as we make it, will last 100 years.—

The current generated by the Dynamos is distributed by the means of 3 separate & distinct classes of conductors, which are called respectively Feeders, Mains & Services.—

The feeders are connected to the Dynamos by means of the Omnibus Wire, as described further on & carry the Electricity to the principal Lighting Centers of the district; they can be compared to trunks where the Electricity is continually conducted & thence divided up amongst the mains, which are connected at the end of the feeders, & which pass through the streets where the stores & dwellings to be lighted are situated; the mains are then tapped by means of service wires, which go into the houses & distribute the electrical current as required.—

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CHAS. BATCHELOR, TREASURER AND GEN'L MANAGER.
SAMUEL INSULL, SECRETARY.

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104 GOERCK STREET.
New York, ...

CABLE ADDRESS: "XYDSUN NEW YORK."

Connections & Regulations of Dynamos in Central Stations.
3 wire system

For the 3 wire system the Dynamos, which are made with an E.M.F. of 120 volts, are invariably connected in series, in order to obtain the requisite E.M.F. necessary to feed the lamps, which as explained above, necessitate each a current of about 100 volts, & are connected between the wires so as to form independant series of 2 lamps, the lamps & series being both independent of each other; we also need 2 dynamos in series in order to be able to make the wire connections, which could not be made on one Machine, except this machine had a neutral brush, which would not be practical.—

The Dynamos being connected in series between themselves are then connected in the following manner.—

Here put in Sketch No. 1.

to what we call the outside wires, which are the main receiving wires of all the current generated.—

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104 GOERCK STREET.

CABLE ADDRESS:
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New York, ...

The foregoing sketch shows the connections for 2 regular dynamos & 2 spares, say of smaller capacity; any number of pairs of dynamos can be connected to the omnibus wires in the same manner. The spare machines are connected to the omnibus through the reversing switches as represented; with the switch handle in a central position, the spares are disconnected from the omnibus wires. Either or both of the spare machines can be multiple arced on either side of the system; thus in case one of the large dynamos should give out, it could be switched off & the 2 spares connected in multiple arc between themselves & in series with the remaining large dynamo, thereby taking the place of the one disabled machine.

Again, whilst running with a light load, both of the large dynamos could be cut out, & the 2 spares could be put in, in series on the 3 wire system.

The field connections are made to under part of switch, so that the field becomes charged when the machine is put in motion whether the main switch is opened or closed. The lamp on head board having the same connections, the E.M.F. of dynamo may

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New York,

CABLE ADDRESS: "XYDBUN NEW YORK."

9.

be approximated before closing the circuit on to the main line. –

The sketch below

Here put in Sketch No 2.

now shows the connection of the feeders to the omnibus wires through the feeder equalizers, these feeder equalizers which are resistance boxes, being used to keep the pressure equal at the foot of each feeder.

The sketch also shows 2 ampere meters for determining the load & balance of system.

An "A" meter should be interpolated in the compensating or neutral omnibus wire. This shows if the system is balanced. – The pointer of this meter is set to zero in the centre of scale, which reads 100 amperes both ways, so that it is easy to determine which side of system is out of order balance & how much. –

The "B" meter is interpolated either on the + or – side of system according to circumstances, either being of course equally efficient. –

The ampere meters should be made so that the pointer will move in the direction of the current. The "B" meter is graduated from left hand of scale (zero) towards the

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CABLE ADDRESS: "XYDSUN NEW YORK."

10.

New York, ...

right + generally has a capacity of about 500 amperes. —

The meters should not be located less than 20 feet from the Dynamos.

The sketch below

Here sketch No. 3.

shows the connections of the regulators (one being one to each machine) to the ordinary Dynamos + also to the 3 spares. — These regulators which work automatically, regulate the fields of the machines + make the current less intense when there is but a small load on, thus keeping down the electrical energy to the minimum requirements, thereby insuring economy. The sketch also shows 4 pressure indicators, (2 indicators to each feeder) one being connected to the + and − side of each feeder by wires called pressure wires, which run from these instruments to the foot of each ~~other~~ feeder. — As their name indicates, they show the pressure at foot of the feeders. —

We also use inside our stations an instrument called a Lightning arrester, which is designed to carry off the atmospheric

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CHAS. BATCHELOR, TREASURER AND GEN'L MANAGER.
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CABLE ADDRESS: "XYDSUN NEW YORK."

11.

New York, ...

Electricity of high tension, which may collect on the air lines during thunder storms. This appliance is connected as per sketch below to the 3 wire main inside of station.—

Here put Sketch No. 4

The 3 right hand plugs of switch connect the system direct to the ground, & should be kept closed when the Dynamos are not running.—

The 3 left hand plugs connect the system to the ground thro' 100 ohms & should be closed when running during a thunder storm.— when running in fair weather, keep all plugs in the switch open.

We also use a ground detector as shown above, which is connected to the station main & shows when either wire of the system, whether +, −, or ± is grounded. The indications of this instrument are best learned by grounding the system thro' 100 ohms on each wire of system alternately, by the 3 left hand plugs of the lightning arrester, moving the switch of the ground detector & observing the results.—

Be sure to open the dead ground plugs of the lightning arrester before starting the Dynamos.

A. Kimmarley Jr.

The drawings to go above are in the Andrews — the information contained in the text was also furnished by Mr Andrews.

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique :
EDISON, PARIS

PARIS, LE Sept. 7th 1884

8, Rue Caumartin

H. Ch. Batchelor
New York

Dear Sir,

In reply to your letter of Aug. 4th we beg to inform you that the Frs. 28842.40 represent the part due to you of the Frs. 30927.80 which the General Meeting of the Société Électrique Edison has voted for the Board of Administration.

We are

Yours truly.
SOCIÉTÉ ÉLECTRIQUE EDISON

ADMINISTRATEUR DÉLÉGUÉ

DREXEL, MORGAN & CO.,

Box 3036 P. O. New York, Sept. 18th 1884

Chas. Batchelor Esq
104 Goerck St.
City

Dear Sir,

We debit your account to-day.

Your acceptance due today Frs. 13334.70
@ 519 3/8 = $2568.67
paid by us, and enclosed cancelled.

Yours truly
Drexel Morgan & Co

Batch-Stock

BERGMANN & CO.

ELECTRICAL WORKS,

Patentees and authorized Manufacturers of

EDISON ELECTRIC LIGHT FIXTURES AND APPLIANCES,

COMBINATION (Electric Light and Gas) FIXTURES A SPECIALTY.

DESIGNS AND ESTIMATES FURNISHED ON APPLICATION.

The Most Complete Facilities for all kinds of Electrical Work.

292, 294, 296 AND 298 AVENUE B,

New York, Sep 29th 1884

Chas Batchelor Esq.
104 Goerck Str. N.Y.

Dear Sir

You are hereby notified that at a special meeting of the Trustees of this Company, held at this office the 27th inst, pursuant to notice sent out by the President on the 24th inst, a dividend of seven (7) per cent on the Capital Stock, was declared for the first 6 months business of the Company, viz from March 1st 1884 to Sept 1st 1884.

You have therefore, as a stock-holder of record, been credited on the books of this company with the sum of $700.00 being 7% on 100 shares.

Very Respy Yours

P H Klein Jr.
Secy.

DREXEL, MORGAN & CO.,
Box 3036 P. O.

New York, Sep 30 1884

Chas Batchelor Esq
Present

Dear Sir,

We credit your account to-day.

Proceeds of
$4000 U.S. Coupon 4% @ 119 7/8 = $4795

Yours truly
per pro DREXEL, MORGAN & CO.
C. Christensen

T. J. HANDFORD.

12, Southampton Buildings,
London W.C. Oct 24 1884

C. Batchelor Esq
33 Avenue de l'Opera
Paris

Dear Sir)

Cable patents

You will remember the above patents in which Mr S. H. Johnson is interested being worked in France some months since - Mr Thirion informed me that all the needful was done to meet the requirements of the law, but I have not heard from him whether you have settled his a/c for what little trouble & expenses he may have been put to in connection with the certificate of the working. Kindly enlighten me upon this point so that I may know exactly how the matter stands & oblige

Dear Sir
Yours faithfully
T. J. Handford

P.S. Who has the certificate of working? Is it in your possession or has it been forwarded to Mr Johnson?

Ans

[ENCLOSURE]

Paris March. 27 1884

T. J. Handford Esq

London

My dear Sir,

I am making the necessary cable to work the two patents Gouraud & Delany and as soon as it is finished I shall notify M. Thirion so that he can comply with the regulations

Very respectfully yours

Chas Batchelor

[ENCLOSURE]

CABINET DE M. CH. THIRION, INGÉNIEUR CIVIL

Maison spéciale pour la garantie de la Propriété industrielle

En France et à l'Étranger (fondée en 1852).

Bureaux : 95, Boulevard Beaumarchais, à PARIS

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Dessins de construction

PARIS. IMP. GR. ELZY

Paris, le 17 Avril 1884

Monsieur Batcheler,
33, avenue de l'Opéra,
Paris

J'ai l'honneur de vous accuser réception de votre estimée du 17 CD, ainsi que du Specimen qui l'accompagne.

Tout me semble en bonne voie ; j'attends donc la communication ultérieure que vous m'annoncez.

Veuillez agréer, Monsieur mes civilités bien empressées.

Ch. Thirion

P.S. Sauf avis contraire, je garderai pour l'annexer au dossier de l'affaire, la lettre de Mr Bonis.

Adresse télégraphique : **THIRION, BREVETS, PARIS.**

[ENCLOSURE]

Copy

Doit
M. Ch Batchelor
Paris
50 Metres Cable antiinduction
et pose du dit cable
@ 3 Fr. = Fr. 150
25 Avril 1884
Pp acquit
Pp Bouis
A Boilard

(Original held by
Shirion)

[ENCLOSURE]

Paris. Apl. 20 1884

Monsieur Shirion -

Boulevard Beaumarchais
Paris

Monsieur,

Ci-inclus vous trouverez une lettre de Maison Bouis avec facture de fabrication et pose de 50 metres de Cable apres les brevets de Gouraud et Delaney - J'ai essayé le Cable moi-même et je ~~trouve~~ crois qu'il sera pour les lignes telephoniques une amelioration importante.

Si vous desirez le voir ou l'essayer vous pouvez vous addresser à M. Aboilard chez Mm Bouis

* Veuillez agreer Monsieur mes civilités empressé

Chas Batchelor

~~Addressez~~ Je vous prie de m'envoyer ~~le plutot possible~~ votre facture

[ENCLOSURE]

le plutôt possible
Veuillez agréer m

The Electric Tube Company.

18 to 24 Bridge St.

T. A. EDISON, Pres.
JOHN KRUESI, Treas
SAMUEL INSULL, Sec'y.

Brooklyn, N. Y., 7th Nov 1884

Chas Batchelor Esq
104 Grand Street
City

Dear Sir, Enclosed please find certificate of indebtedness of this Company in favor of yourself for $800 in payment of dividend of 80% on the Stock held by you

It was decided to loan the dividend to the Company in order to provide more capital for the conduct of the business

Please own receipt

Yours truly

Sam'l Insull Secretary

EDISON LAMP COMPANY.

THOMAS A. EDISON, PRESIDENT,
FRANCIS R. UPTON, TREASURER.

EAST NEWARK, N. J., Nov. 18, 188X

Chas. Batchelor Esq

Dear Batch:

I have thought over your remarks of yesterday and concluded that I will allow the present arrangement as to salary continue i.e. $60— per week for half my time, until such time as the interest on the original investment has been paid back in dividends

Yrs. Truly

Francis R. Upton

THOMAS A. EDISON,
No. 65 FIFTH AVENUE.

NEW YORK, Mar 26th 1884

Chas. Batchelor Esq
Edison Machine Works
104 Goerck Street
City

Dear Sir.

I debited your account on the 25th inst with $34.54/100 amount of check sent Manning Freeman for Paper.

Yours truly
Thos. A. Edison

CHARLES BATCHELOR COLLECTION

1885

EDISON LAMP COMPANY.

THOMAS A. EDISON, President.
FRANCIS R. UPTON, Gen'l M'g'r & Treas.

EAST NEWARK, N. J. Feb. 3 1885.

Dear Mr Batchelor,-

I cannot decide regarding paying the dividend until after the 20th of this month, for there are certain unknown factors entering in the case up to this time mentioned.

I shall consider the offer contained in your letter of Jan. 30 as good up to this time mentioned.

Yours Truly,
EDISON LAMP COMPANY,
By Francis R. Upton Treas.

Drexel, Morgan & Co.

P.O. Box 3036.

New York Mch. 27. 1885.

My dear Mr. Batchelor,

I have just seen your letter & will recommend whatever is fair abt Mr. Upton. Ask him to come & see me, as there are some points not quite clear in my mind.

I was on the point of sending you the Enclos when your letter arrived. Whatever we arrange with Mr. Upton, need not affect the figures in the Enclosed, as we can cover his case by a subsequent resolution of the Board.

Will you kindly get Edison's & the other signatures between now & Monday (on page 5 as marked), when there will be a Board meeting. If it is all signed, I think it will go through the Board easier. – Get Edison's signature anyway.

Let me have enclosed back by noon Monday –

Yrs very truly

C. Coster

Brief-Adresse: Commandit-Gesellschaft, Wien, III. Baumgasse Nr. 5. — Telegramm-Adresse: Brückneross, Wien, Baumgasse 5.

COMMANDIT-GESELLSCHAFT FÜR ANGEWANDTE ELEKTRICITÄT.

BRÜCKNER, ROSS & CONSORTEN.

Alleinige Concessionäre
der
Société des machines magnéto-électriques Gramme
IN PARIS
für die
Erzeugung der Gramme'schen Apparate
in
Oesterreich-Ungarn.

Edisons
elektrisches Beleuchtungssystem.

ELEKTRISCHE BELEUCHTUNG.

Elektrische Transmission
der Kraft.

GALVANOPLASTIK.

ELEKTROLYSE.

WIEN, le 13/4 1885
III. Baumgasse 5.

Mon cher Monsieur

J'ai bien reçu dans le temps votre honorée du 4/2 mais pas la lettre détaillée dont vous parlez.

L'affaire avec la „Vienna Gas Company" est maintenant parfaitement réglée, en partie parceque nous n'étions pas à mesure de faire des offres définitives faute de renseignements mais surtout parceque la Cie Edison a jugé utile de procéder contre d'une manière que nous jugeons très imprudent. La „Gas Company" dans ses offres à la cour impériale a demandé une somme, qui si tout va bien couvrira les frais d'entretien de l'installation mais qui en tous cas ne laisse pas un sou pour les interets ou l'amortissement du capital engagé. Il est tout naturel que de pareilles

ou nous avons eu connaissance de cette offre nous étions certain quelle serait accepté vu que jamais la court recevra la lumière electrique meilleur marché et que la „Gas Company" offre toute la securité qu'on pourra esperer, elle terminera l'affaire certainement même si elle devra depenser deux millions au lieu d'une.

Nous avons donc jugé prudent de changer immédiatement la tactique et de declarer a la „Gas Company" que comme nous serons pas dans l'état de faire des offres plus avantageux, nous renoncerons tout a fait a cette affaire et par contre nous serons tout a fait disposés d'aider la „Gas Company" dans son entreprise avec notre experience gagné surtout dans l'installation dans les theatres.

Nous avons declaré en même temps que nous renoncerons a toute demarche qui rendra le traité definitif entre la G. C et la court difficile.

Cette déclaration a été très bien accueillie et nous avons commencé des pourparlers dans le but de fournir la plus grande partie du materiel qui j'en suis certain auraient

si on nous forcera de changer le système et d'accepter une autre lampe mais il est bien probable que nous nous déciderons a procéder ainsi si nous ne pouvons pas nous procurer le materiel necessaire sans le concours de la Sté de Paris.

Je sais bien que vos conventions avec la Sté de Paris vous interdisent des fournitures directes aux clients en Europe, mais je suppose que vous fournirez des lampes a des agents qui les vendent ailleurs et je vous prie de me dire d'ailleurs ou a quel prix vous vendés dans ce cas les lampes pour des commandes de 10000 lampes p. 8 a fournir dans le courant d'une année. Vous pourriez peut être m'indiquer l'adresse d'un de ces agents.

Le projet d'après ce qu'il paraît definitivement accepté par la Gas Company est d'établir une usine dans une distance de 2500 met. environ de l'opera. On emploiera des machines de 1000 ou 2000 volt et de 100 à 150 lamp. si on les trouve et on prétend que Crompton a pris l'engagement de fournir ces machines.

Le courant sera employé pendant la journée a charger des accumulateurs Syst

aboutis.
Grand fut donc notre étonnement lorsque après quelques semaines nous fumes informés par la G. C qu'il renonceront à toute entente avec nous vu la grande hostilité avec laquelle nous aurons agités contre eux auprès des personnes compétentes.
Des informations que nous avons pris alors nous ont montré que c'était la Ste Edison qui sans nous informer jouait ce tour et comme nous ne pourrion pas nier les relations existant entre nous et la Ste E nous étions forcés de trouver que la C. G était tout à fait dans son droit.
Ceci et en outre la manière de ces MM a Paris de traiter les affaires comme si leurs clients payant comme nous tous les ans une somme assez ronde pour leur materiel devraient être très obligés contre eux pour l'aimabilité qu'on veut bien leur livrer des lampes et accessoires nous ont forcés de renoncer tout a fait à continuer des relations avec la Ste Edison.
Moi personnellement comme grand partisan de Mr. Edison je regretterai beaucoup

de Calo un accumulateurs qui ne se distingue pas beaucoup du type Faure primitif. Il est probable qu'on emploiera des lampes Edison parceque Mr. Biedermann que vous connaissez je croie est un des faiseurs de ce projet.

Il me semble très probable que ces Messieurs realiseront ce projet peu avantageux suivant mon avis parceque la question de l'argent qui ruinera tout autre entrepreneur n'existe pas pour eux.

Je ne sais pas si on vous a informé que nous avons eu d'après 2 ans et demi de fonctionnement la première interruption de l'éclairage dans le theatre de Brünn pour une soirée et ceci suivant mon avis encore grace a Mr Tehl, je suis seulement etonné que ce cas ne c'est pas produit plus tot.

Nous vous rappelez peut être que les cables qui reunissent les machines Edison avec le cable principal etaient placés sous le pavé. Nous avons vu maintenant que l'isolement de ces cables laisse beaucoup a desirer la plus grande partie etait tous simplement isolé avec du ruban compoundé qu'un isolement qui perd dans un

peu d'humidité en très peu de temps. Sans pouvoir indiquer, tous ces cables étaient en outre dans un peloton impossible à débrouiller sans couper les fils. Il est donc tout naturel qu'un jour ou peu avant le commencement de la représentation un contact s'est formé qui a brûlé les fils conducteurs aux aimants. Il était impossible de réparer immédiatement la panne de sorte que la représentation ne pouvait pas avoir lieu.

En attendant vos nouvelles veuillez mon cher Monsieur agréer l'assurance de ma parfaite considération

Thos.

Mr. Chas Batchelor Esq.
104 Goerck street New York.

New York, April 13, 1885.

Dear Sir:-

It having been deemed necessary by the Railway Telegraph and Telephone Company to secure moneys for the further conduct of experiments and the procuring of additional patents, a Resolution was passed at the last meeting of the Board of Directors requesting each of the Stockholders of the Company to turn into the Treasury of the Company five per cent of his holdings.

If you will send your present certificates to the Secretary, Mr Samuel Insull, at the office of the Company No. 65 Fifth Avenue, New York City, properly endorsed a new certificate will be issued for the amount of your present holdings, less five per centum.

negotiations have been concluded for the sale of a large portion of the Treasury stock and for the consummation only await your compliance with the above request, trust you will give this matter your immediate attention.

Yours truly,

Railway Telegraph and Telephone Company

by

President.

505

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ

Grand Diplôme d'honneur

PARIS 1881

Ivry-sur-Seine, le 18th April 1885.

5, RUE DU PARC.

Chas. Batchelor Esqr.

Editor Machine Works.

104 Goerck Street.

New York.

Dear Sir,

We beg to inform you that, according to the instructions contained in your letter of the 28th March last to the Sr. Continental, we have transferred to the Société Electrique Edison the sum of 100 Rs which figured in our books to your credit.

Yours faithfully

SOCIÉTÉ Indust. et Comm. EDISON

A. Pieon

THOMAS A. EDISON,
PRESIDENT.

(Form 21.)

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,
104 GOERCK STREET,

CABLE ADDRESS:
"XYDSUN NEW YORK."

New York, April 23rd '85

For torpedo Motor:-

Armature res: about 2 ohms

Field:-

2 layers of #10 (B.W.G.) wire.

In testing, the speed will most likely be a little below 700, the req^d speed: so shunt the field with low resistances (a piece of iron wire or so) till the speed is right & then calculate how much of the #10 wire can be taken off: this will reduce the weight of the machine quite a good deal.

It is likely 3/4 of a layer can be taken off. If so do it thus:- that is leave the wire nearest the ends.

Max - 120 Amp. 300 Volts constant

For railroad motor :-

Armature #9 (.144) wire. 18" long 12" dia. Shed 5 x

1 #9 (.144) three times round $\boxed{\frac{000}{000}}$

[illegible] Cons. Hocks. Hs 1/2

Magnet :-

Section 18" x 2½ Effective length (4 times)

Thick wire = #8 wire 00 00 4 in Multi. Arc 23 times round

= 2 layers of #8 wire = 92 times round [illegible]

= 76 lbs.

Fine wire - 220 lbs in all of #19 (.144)

= 55 lbs on each side of the magnets. = 241 Ohms

April 23rd 1885

Mr Chas. Batchelor Esq

104 Goerck Street

508

To THOMAS A. EDISON, Dr.

OFFICE,
65 FIFTH AVENUE, N. Y.

Statement.

Feb	12	To Statement Rendered	11613	89		
Mar	31	By Telephone Royalty for March			100	00
Apr	23	" " " " April			100	00
		By Balance			11413	89
			11613	89	11613	89
Apr	23	To Balance due	$11413	89		

B. [illegible] Field

Washington Building,
1. Broadway,
New York, 8th May 1888.

364

Dear Mr. Johnson,

I return with many thanks Mr Batchelor's letter, enclosed in yours of yesterday. I have read them both with much interest & am glad to find that such good progress is being made with the work.

Remain
Very truly Your friend,
Jas W. Field.

E. H. Johnson Esq

515

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diplome d'Honneur.

Adresse Telegraphique:
EDISON, PARIS.

Paris, le 8 Mai 1885

8, Rue de Caumartin.

Ch. Batchelor Esqre
104 Gerck Street
New York.

Dear Sir,

We beg to hand you enclosed copy of a letter which we have addressed this day to Mr. Edison & to the Edison E. Light Co of Eur.ts Ld of your city.

Kindly take note of the contents of that letter &

Believe us,

Dear Sir,

Yours very sincerely
COMPAGNIE CONTINENTALE EDISON

[signature]
ADMINISTRATEUR DÉLÉGUÉ

1 letter

We would be very much obliged if you have us cabled by Mr Valentin all which will go on in the above mentioned matter. You are well aware that it is of the utmost importance to come to a conclusion in the shortest possible delay if the whole Edison business is not to be upset.

[signature]

[ENCLOSURE]

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
Paris 1881
GRAND DIPLOME D'HONNEUR

ADRESSE TÉLÉGRAPHIQUE
EDISON, PARIS

Paris, le 8 Mai 1885

33, Avenue de l'Opéra

Confidential

COPIE

Thomas Alva Edison Esqre
New York.

Dear Sir,

Since Mr Siegel received the necessary powers for the fusion of the three French Edison Companies, we have been very hard at work to come to a final arrangement of all these matters and we were very near attaining our object, when suddenly the French patent suit versus Maxim brought facts to the light, which would [illegible] it absolutely impossible for the new society to accept the terms of the arrangement with you as was proposed.

The facts above referred to are the following:

As you are aware, we had brought on a suit here against Maxim, to enforce our monopoly of the manufacture & sale of incandescent lamps in France.

We stated that his lamp was an infringement on our first & principal lamp patents, which were the following:

Set. 2 taken on the 29th May 1879
2o 3 " " " 29 Nov. 1879
2o 4 certificate of addition of Set. 2.

Maxim (represented by his solicitor here (Mr Kelly) said his lamp was no infringement on ours & that on the other hand the above mentioned patents were void for [illegible]

[ENCLOSURE]

reasons of which the principal are the following:

a) valid patents are only granted in France for new inventions. In order to be considered as new, an invention must not have been published anywhere sufficiently to enable anyone to carry it out.

Set 3, our principal lamp patent, was filed here on the 20th Novbr 1879. Was in a solicitor proved that the corresponding Canadian patent of Mr Edison was open to the public on the 17th November 1879, three days before the filing of the corresponding patent in France.

We consulted our advocate, Mr Fouillet, who told us that, such being the case, any lawsuit being based on our patent set 3 would be lost; that moreover if one would ask a decision of Court the patent would be publicly declared void.

Mr Fouillet is the first authority in France on patent matters & he repeated that on this question there was not the slightest doubt to be had.

b. Improvements on an invention which forms the subject of a patent may be protected by certificates of addition; but it is absolutely necessary in order to be valid that the certificate of addition should be an improvement on the invention as described in the principal patent.

Now remark that:

Set 2 describes a lamp with a platinum burner

Set 3 " " " " a carbon burner

Set 4 " the manufacturing of carbon burners for incandes. = cent lamps.

It is therefore quite clear that Set 4 ought to have been taken out as certificate of addition to Set 3. (Carbon lamps) but Brandon, your solicitor of patents at the time, through neglect or incapacity, took out Set 4 as a certificate of addition

[ENCLOSURE]

to Set 2 (i.e. Platinum lamps)

Through this most unfortunate circumstance, it is most probable that in any action, the Court would declare set 4. (certificate of addition) valueless as not describing an improvement on the invention as described in the principal patent.

The cannot, according to the law here describe in the principal patent, platinum lamps; in the certificate of addition, the manufacturing of Carbon burners. To conclude, the result of a lawsuit here would be that our principal lamp patents would be publicly declared void.

c Maxim produced here before the experts a translation of the proceedings "Sawyer & Mann versus Edison" in the U.S.

The matter in controversy "carbonized paper for electric lamps" seems according to the last decision of the American Courts, to be in favor of our competitors.

Under these circumstances if we would agree to pay you such a heavy royalty as the one proposed in the new treaty & such a large profit as stated in the new Statutes, it is evident that it would be impossible for us to make arrangements with our competitors granting them advantages which would induce them to let fall their pretentions in the patent suits.

Our interest in these circumstances would be, to make arrangements first with Maxim about his patents; then to get his consent not to make public anything which might harm our patents - afterwards to come to an arrangement with the Swan people; to get in that way a kind of monopoly as we expected to have it through our patents.

In order to make such arrangements, it is necessary

[ENCLOSURE]

4

that we give certain advantages to the people in question in form of a royalty or a profit.

We must ask you therefore to accept the offer which we would make you now in order to make the fusion of the 3 Companies, in asking for the founder shares of your Company twelve centimes per lamp, whatever may be the system of lamp used by us; in turning us over three thousand instead of two thousand founder shares; so that we could be able to interest the other Companies in our profits as stated above.

We propose you the above conditions in order to be able to induce our shareholders to make a fusion even under the present unfavorable circumstances.

It would be necessary to have your acceptance of the present conditions by return of post (i.e. the authorization given to Mr Siegel to accept them for you) so that we can make the fusion of the 3 Paris Companies in the present half year together with our ordinary general meeting of shareholders.

Now we will try & show you what would happen should you refuse to accept our proposals.

First all our patent suits would be lost, our principal lamp patents would be publicly declared void, & this circumstance through it only applies to France, would certainly have the greatest effect, not only in Europe, but also in America.

There would then be nothing else left to the Cie Continentale but to liquidate within a very short period for loss of 3/4 of its capital; there would then never

[ENCLOSURE]

be any profit to arise from our Companies for the Light Co. & its bondholders, nor even for any of the American manufacturing Companies who same as now would be prevented from selling in Europe.

All persons now connected with the Edison system have worked very hard & at the moment when they are now about to reap the fruit of their work, they see all their hopes vanish entirely.

The responsibility we have towards our shareholders makes it our duty to tell them clearly the facts in our next meeting, whatever may be the consequence, if till then we have not come to an arrangement with you, so that at least our responsibility will be covered.

There is but very little time to accept the proposition we make you, not only in our own interest, but also in yours & in the interest of your bondholders, having had the pleasure of seeing some of them here & having promised them that shortly everything would be settled to General satisfaction, as it was not possible to forsee that such unhappy circumstances would arise.

We will wire to you today that now & very unfavorable incidents have arisen in the lawsuits urging you to have a meeting of your Board & of your Bondholders called together as soon as possible in order to discuss on the matters mentioned in this letter.

As soon as we have your answer, which please communicate at the same time as to us, also to Mr. E. Wallerstein & to Mr. Siegel. We will call in the shortest period an extraordinary meeting so that next

[ENCLOSURE]

monthly matters can be settled.

On receipt of this, kindly let us know your accord by wire.

Yours sincerely
Cie Continentale Edison
(signed) L. Aau
adm. délégué

COPIE

Società Generale Italiana di Elettricità

SISTEMA EDISON

SOCIETÀ ANONIMA

Capitale: 3,000,000
Versato: 3,000,000

DIPLOMA D'ONORE
Esposizione Internaz. d'Elettricità
1884 - TORINO - 1884

Gran Diploma d'Onore all'Esposizione di Parigi 1881.

Milano, May 11th/85

Indirizzo per telegrammi: Edison Milano

Chas. Batchelor Esq.

My dear Sir,

Yours of 26th has come to hand and I hasten to reply. The quotations asked for on 400 & 240 Ampere Machines were not for competition with lower rates offered elsewhere but to ascertain bottom prices so as to be able to make a close estimate on installations for which Sautter Lemonier & Cie. had given very low estimates.

We still await replies from these parties & hope to be able to secure at least one of these contracts.

The figures you have of late quoted us will secure you favorable consideration should we however receive other offers which would make it necessary for you to reduce

them in order to compete successfully will inform you of the fact immediately and give you figures.
We have quite a number of Machines in stock and I don't think it likely that we will place any orders for a month or two.
In dealing with our people it is always better to quote a figure & then offer a reduction reducing it to a certain sum, than to quote that sum right off.
Our Isolated business is rather dull at present but we expect it to pick up during the Summer.
We continue to connect Lamps to our Station in Milan which may make it necessary to add another "C" (Jumbo) Dynamo by next winter.
Will advise you in advance when a good offer for a Jumbo with A.B. would be accepted.
Thanking you for past favors will continue to secure to you favorable consideration.

Yours truly J. W. Lieb
via S. Radegonda 7 A
Milano

514

THOMAS A. EDISON,
No. 65 FIFTH AVENUE,

New York, 16th May 188-

Chas Batchelor Esq
City

Dear Sir.

Enclosed please find certificate No 30 for 237 shares of the Railway Telephone & Telegraph Company.

This number of shares is made up as follows

Your original holding was for 250 shares
certificate sent me 249 shs
5% of 250 shares say 12 12
certificate enclosed 237 shs
Please own receipt.

Yours truly
Saml Insull Secy

May 22nd 1885

517

M. Chas. Batchelor
1011 Grand Street

To THOMAS A. EDISON, Dr.

OFFICE,
65 FIFTH AVENUE, N. Y.

Statement

Apl	23	To Balance due	11413	89		
May	1	By 10 Per cent of $332444.90/100 amount credited by Edison Electric Light Co on account of claim $ 100.000 recognized by them in agreement of April 23rd 1885 Batchelor being entitled to 10 per cent of said $100.000/as is paid/ under verbal agreement with me.			3324	13
"	4	By 5 Shares of Stock returned as per letter of May 4th 1885			1185	57
"	11	To Balance due Edison Electric Light Co by Mr and Mrs Batchelor for an increase of Capital	3810	00		
"	22	By Telephone Royalty for May			100	00
		By Balance			11313	89
			15223	89	15223	89
May	22	To Balance due	11313	89		

521

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diplome d'Honneur.

Adresse Télégraphique:
EDISON, PARIS.

Paris, le 29th May 1885

8, Rue de Caumartin.

Chas Batchelor Esqre
New York.

Dear Sir,

As you are aware according to art 16 of our Statutes, the present administrators (Members of the Board) of this Company were elected in 1882 for a period of three years.

The General ordinary meeting of shareholders which is to take place the 25th of June next, will therefore have to renew the powers of the Board.

In consequence we request you kindly by return of mail to let us know what are your intentions in this respect, i.e. if you are desirous that your reelection as member of our Board should be proposed to the above mentioned General meeting.

Expecting your kind reply
We are
Dear Sir
Yours Sincerely

President du Conseil d'Adm.

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique:
EDISON, PARIS

PARIS, LE 29 May 1886
8, Rue Caumartin

Ch. Batchelor Esq.
New York

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Yours very sincerely

Président du Conseil d'Adon

H. Chotard

SOCIÉTÉ INDUSTRIELLE ET COMMERCIALE EDISON

Société Anonyme, Capital : 1.500.000 Francs

EXPOSITION INTERNATIONALE D'ELECTRICITÉ
Grand Diplôme
d'honneur
PARIS 1881

Ivry-sur-Seine, le 29th May 1885
5, RUE DU PARC.

Chs Batchelor Esqre
New York.

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Expecting your kind reply
We are
Dear Sir
Yours sincerely

P.S. Please answer
8 rue Caumartin

President du Conseil d'Adon

A C Chatard

Paris, le 1er Juin 1885.

Nous avons l'honneur de vous informer que les Assemblées générales ordinaires des Sociétés françaises Edison auront lieu au Siège social, 8, rue Caumartin, le Jeudi 25 Juin 1885 :

La *Société Industrielle et Commerciale Edison*, à 3 heures;

La *Compagnie Continentale Edison*, à 3 heures et demie;

La *Société Électrique Edison*, à 4 heures,

pour délibérer et voter sur toutes propositions à l'ordre du jour.

Dans le cas où il ne vous serait pas possible d'assister à ces Assemblées, nous vous remettons ci-inclus des Pouvoirs que nous vous prions, si vous le jugez convenable, de vouloir bien nous retourner revêtus de votre signature, pour que vous soyez représenté auxdites Assemblées.

Veuillez agréer, M , l'assurance de notre considération distinguée.

LES CONSEILS D'ADMINISTRATIONS.

275. — Ve Edina Pérou.

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"EDISON NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

Subject _____ New York, _____

Torpedo Motor Test:- June 27th 1880

Main Volts	Counter Volts	Volts on Lead	Amps in Main Circuit	Speed of Motor	Remarks
540	300				
600	345	89	24	582	
550	280	84			
590	280	83	29		
600	310	87	26		
605	320	88	26		3 Rows of Lamps + Equalizer
610	325	87	24	586	
615	335	87	24		
620	338	87	25		
610	337	87	24		
600	334	86	24		
605	332	84	24	592	
601	328	76	24		4 Rows +
605	325	70	25		5 " +
605	321	61	25		7 " +
607	323	51	26		9 " +
620	308	65	29		6 " +
610	305	66	28	610	6 " +
595	296	53	27		9 " +

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

Subject.....

New York,.....

Main Volts	Counter Volts	Volts on Load	Amp in. Main Circuit	Speed of Motor	Remarks
600	295	57	30	560	9 Rows +
600	289	57	20		9 Rows +
603	300 (Omohoe Motor pretty High)	57	30		9 Rows + Shunted by 14 Blocks
620	324	59	28		9 Rows + 20 Blocks
635	337	62	29	610	9 Rows + 26 Blocks
650	338	63	30		9 Rows + 32 Blocks
650	343	61	30	640	9 Rows 36 Blocks
640	332	58	28		9 Rows + All in = 5.84 Ohms
630	338	59	28	600	
645	350	61	29	640	9 Rows + Shunt 4.26 Ohms
We now put 1 Ohm more in Main Line					
620	360	~~30~~ 62	30		9 Rows + Shunt 4.26

THOMAS A. EDISON,
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Nos. 92 TO 108 GOERCK STREET,

New York,

Subject

600 Volt Machine

Armature 54 Blocks, 1 #9 Wire, 6 layers

At 30 Amperes, Amp spires =

$54 \times 6 \times 30 = 9720$

Magnets: Volts 115

Res of ea core 20 Ohms

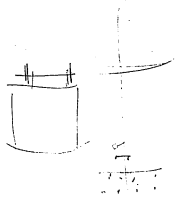
Current in each core when in mult. arc, 5.6

Spires on Each Core. 3550

$\therefore$ Amp-spires = $3550 \times 4 \times 5.6 = 80,192$

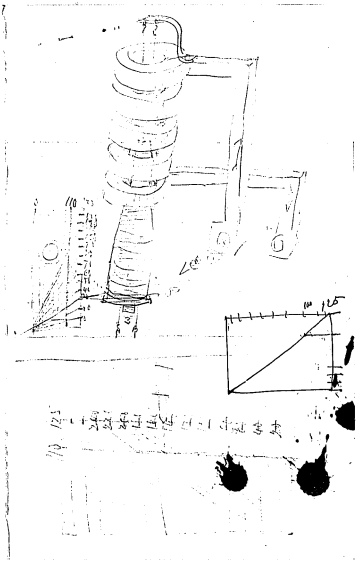
Primary 11.6
Second 73

1.32
64.50



150
11
76.50

[ATTACHMENT]



Boston - July 1 '85

It seems to me that if bare cylinder shows rise of 15° covering it with a thick coating of wire through which conduction of heat must take place not endosmosis through the metal wire but cotton must necessarily raise this 15° by accumulation until the external surface of the armature or wire has reached such a temperature as the rapidity of radiation equals the generation, this would account for the extra 20 degs when the wire was on which is due to the original 15° in the iron & not to any in the wire itself - I don't

believe much in whirlpools in large wire = you could prove the amount of heat in wire by using a wooden armature & winding it in the regular way with commutator etc & see the heat = even if you did get heat, this may not be due to whirlpools but to an entirely different cause to wit - ~~If~~ you know the wire on an armature when brushes are off is a closed loop - if by unsymmetrical winding or ends etc one side of the loop is larger than the other there will be a difference of electromotive force & this flowing around the loop generate heat = you could prove this by putting

3

two rings on a block of wood over the commutator & breaking this loop where it is soldered to a commutator block, where both ends of the loop meet, ~~as~~ instead of having them together, separate & connect one end to one ring & the other end to other ring with two brushes on rings you could run machine not using the regular brushes & thus get reversals & ascertain just how much heat was thus generated = again another way is to run an armature without brushes - get temperature - then disconnect

4

The two ~~brushes~~ wires from one of the commutator blocks & leave them apart (16) insulated from each other thus breaking ~~the~~ loop - then start with the temperature of air & make a heat test if the 2nd test shows less heat then there is a circulation of current within the loop due to want of symmetry at the ends - or pole pieces or somewhere =

Regarding the primary heating of the iron cylinder alone This is the true bug I think ~~you~~ How would it do to put ~~tape the [illegible]~~ in a simple shaft tape it & run it in regular field - If it is

5

the bolts the amount of heat could perhaps be reduced by using brass with phosphorus ~~[illegible]~~ or arsenic or even plain brass instead of iron -
with iron the lines of force are conducted right through it & of course cut the metal with brass the iron of the plates would act as a shield & think if you could get the conducting power of the brass as poor as iron this would be an improvement if its the cause =

= Can't you make a cylinder in the regular way with alternate plates & tissue & with flat tools take a cut over the surface of iron so the tissue will show & with two

6

wires & sounder you cannot get a circuit on surface of cylinder = The ~~[illegible]~~ Burr known by the tool connects the plates together -

I think that clutch a good one = ~~[illegible]~~ ~~[illegible]~~ - I spose you have got the plans for the new motor for the other truck ~~[illegible]~~ nearly ready - If I remember right the shape of your field on the truck motor is of such a character as not to bring the neutral point very close to the theoretical its thus - should it be like this

7

glad you got money from Will
are they using the machines
yet =

Did we beat Weston at Phila
& will our bad luck with
machines go against us as
related to Weston

Should find out who is responsible
for Des Moines & change Walter
time & fare to them -

If you could get Simms work
it might turn out big thing
some day - Do you mean to
build the whole or only
motor = How did other one
come out Have they tested
it -

If you have struck a non commutator
machine you have the biggest thing
for the century but I'm afraid there is a big
Edison

Statement of
Mr Chas Batchelor's Account

			Dr. $		Cr. $	
1885						
July	1	By Telephone Royalty			100	00
"	1	50 cash	100	00		
Aug	1	By " Royalty			100	00
"	5	" "	100	00		
"	7	" " note			500	00
"	7	" "	500	00		
Sept	1	" " Royalty			100	00
"	1	" "	100	00		
Oct	1	" " "			100	00
"	1	" "	100	00		
"	5	" " note			789	59
"	5	" "	789	59		
Nov	1	" " Royalty			100	00
"	2	" "	100	00		
"	28	" cash			200	00
"	30	" "	300	00		
Dec 1886	1	" Royalty			100	00
Jan	1	" "			100	00
"	1	" "	100	00		
"	1	" " for Canada in 1885			400	00
"	18	" "	400	00		
Feb	1	" Royalty			100	00
"	1	" "	100	00		
Mar	1	" " "			100	00
"	1	" "	100	00		
Apr	1	" " "			100	00
"	1	" "	100	00		
May	1	" "			100	00
"	1	" "	100	00		
June	1	" "			100	00
"	1	" "	100	00		
July	1	" "			100	00
Aug	1	" "			100	00
"	2	" "	200	00		
Sept	1	" "			100	00
Oct	1	" "			100	00
Nov	1	" "			100	00
"	1	" "	300	00		
Dec 1887	1	" "			100	00
Jan	1	" "			100	00
"	1	" " Canada for 1886			400	00
"	3	" "	200	00		
"	15	" "	400	00		
Feb	1	" "			100	00
"	1	" "	100	00		
Mar	1	" "			100	00
"	1	" "	100	00		
		Carried Forward	4389	59	4389	59

			Dr.		Cr.	
1887		Brot. Forward	$4389	59	4389	59
Apr	1	By Royalty			100	00
"	6	To Cash	100	00		
May	1	" "			100	00
"	5	" "	100	00		
"	1	By 10% of 9838.54 after deducting Tourey Stone and Auerlach's share $3279.51 received by Drexel Morgan and Co on a/c Indian and Colonial Light Co. Stock			655	90
June	1	By Royalty			100	00
"	1	To Cash	100	00		
July	1	" "			100	00
Aug	1	" "			100	00
Sept	1	" "			100	00
"	1	" " "	300	00		
Oct	1	" " "			100	00
"	13	" " "	100	00		
Nov	1	" " "			100	00
"	2	" " "	100	00		
"	26	" One Thermometer ✓	1	75		
Dec	1	" Royalty			100	00
"	2	" Cash	100	00		
1888 Jan	1	" " "			100	00
Feb	1	" " "	100	00	100	00
"	1	" "	100	00		
Jan	3	" P.O. Order to Chas. Mullan 82 Francs	16	40		
"	10	" Custom fees on Parcel from P.O. No 62693 ✓		85		
Mar	1	By Royalty			100	00
Apr	1	" "			100	00
May	1	" "			100	00
"	19	To Cash	400	00		
June	1	" "			100	00
"	7	" " "	100	00		
July	1	" "			100	00
"	3	" " "	100	00		
Aug	1	" "			100	00
"	7	" " "	100	00		
Sept	1	" "			100	00
"	7	" " "	100	00		
Oct	1	" "			100	00
"	1	" " "	100	00		
Nov	1	" " "			100	00
"	1	" "	100	00		
Oct	15	" "	19480	50		
Dec	1	" "			100	00
"	1	" "	100	00		
"	31	" Bottle Brandy	2	50		
		Carried Forward.	26091	59	7145	49

7045.49

26091.59
19583.
6508.59

7045.49
6508.59
536.90

			Dr.		Cr.	
1888		Brot. Forward	$ 26091	59	$ 7145	49
Dec	31	By Amount allowed for 450 Shares of the Capital Stock of the Edison Phonograph Co. Sold to Mr. Edison in June 28-1888-			29970	00
Dec	31	By 10% on Final Payment of 66755.70/100 from the Edison Electric Light Co in full payment of their 100 000. Agreement dated April 23-1885			6675	57
Dec	31	By 10% of 1332.21 being the amount received by Drexel Morgan and Co after deducting Porter Lowrey & Stone share $666.12			133	22
1889						
Jan	1	By Royalty			100	00
"	1	To Cash	100	00		
"	9	" "	2622	37		
Feb	1	" "	100	00		
"	1	By Royalty			100	00
		To Balance	15210	32		
			44124	28	44124	28
Feb	1	To Balance due Mr Batchelor			15210	32

Balance due Mr Batchelor
$ 15210.32

July 13th 1885

Mr Chas Batchelor
1011 Dorsch Street

To THOMAS A. EDISON, Dr.

OFFICE,
65 FIFTH AVENUE, N. Y.

Statement

			$		$	
May	22	To Bill Rendered	11313	89		
May	30	" cash	100	00		
June	1	By Royalty for June			100	00
July	1	" " " July			100	00
"	1	To cash	100	00		
"	13	By Release given this day			11313	89
			$11513	89	$11513	89

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
Paris 1881
GRAND DIPLOME D'HONNEUR

ADRESSE TÉLÉGRAPHIQUE
EDISON, PARIS

Paris le 4 Sept 1885

8, rue Caumartin

Dear Mr Batchelor,

I just return from the sea side & hoped very much to find here the various ratifications for the German business, as well as for the fusion of the Paris Companies & more especially the answer of Mr Dyer in the Canadian patent matter.

I thought that I could call at once an extraordinary meeting of the French & German Coys & that I could now give our lawyers favorable news for our Maximfluit & all these hopes are vain.

I am personally really utterly discouraged, as I see that you seem to laugh at the strenuous efforts which Mr Magnin, Tom, Chatard & myself are making since 6 months to uphold your business, & that your people are blind enough to believe perhaps that they could derive the slightest advantage through the falling of the French Companies. Your wire, which we just received:

"Afraid Directors never accept plan
"only nets three thousand my
"figuring am correct if seventy five
"hundred guaranteed can close promptly
"+ Dyson"

is not clear. You speak of 3000 & 7500 & then you speak again of a guarantee. I dont know if you mean founder shares or amounts of royalty, but, what I know & what Mr Upton knows too, is that we cannot come, in any other way, to an arrangement that would suit everybody, except by the plain accepting of the conditions discussed with Mr Upton, who knows perfectly our situation & our feelings.

I leave tonight again, because we have many matters to attend in Austria & Germany & I intend being back on the 20th inst latest, although I am going to Pest, Bucharest, Amsterdam Antwerp besides Vienna & Berlin. Will you do me the favor & have the above matters completly settled by that time in one way or the other, because I can tell you very frankly that I will resign immediately, when I see that there is no possibility to come to a suitable reorganisation. To give you an idea of the neglect of all our business matters, or rather of your proper business matters, by your people over there: On the 27th of July a letter was announced to us by the Light Coy in the Maxim matter at "an early date" & up to present we have not received one word although the matter is one of the most important one & of the very highest interest to our Companies. Then again, at least six weeks ago we had a wire from the European Coy that the

German treaty would be ratified at once as soon as a definite text would be to hand. Well this text is in N.Y. since more than five weeks of the settlement was asked by the German Coy of ourselves repeatedly of Mr Edison & of the Light Coy & up to date we have received nothing.

In the fusion matter, if the extraordinary meeting cannot be called in October, it will be very difficult to come to an arrangement with the shareholders.

To conclude, I only see one way of bringing our companies out of the muddle, & that is that you ratify the contracts which you have now in hand absolutely as they lay before you; & if you have only the slightest confidence in my doing, you will convince your colleagues that what we ask for is reasonable & any further delay will be disastrous for the Edison interests all over the world.

Yours very sincerely

[signature]

We wired today to you
Xydsun N.Y.
"Cannot understand cable
"Upton knows changes treaty
"or guarantees impossible, hurry
"final decision."

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

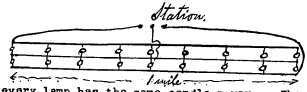
NEW YORK,

Subject Street Lighting.

Oct.12,1885.

The following is a comparison of the weight of copper wire necessary for the two systems of incandescent street lighting-three wire and municipal:

On the three-wire system--one of the simplest methods for a street say one mile long on either side of the station is, as in sketch:



this way every lamp has the same candle power. The main wires are, of course, a mile and a half long but this is shorter than if feeders were run as there would have to be at least two in this case for a fairly uniform potential at lamps. Take for example 18 lamps and say each lamp takes 100 Volts and one Ampere (about 20 candle power) The total current on three-wire system would be nine Amperes, allow a 15 per-cent drop, equal to 17 1-2 Volts on a hundred; then total Volts 235. It will be found that the right size of wire to use for that drop is a No.7, B.W.G. for two wires and a No.10, for middle wire. Will therefore want three miles of No.7, and one mile of No.10, or a total weight of wire of a little more than 1800 lbs.

On the Municipal system, lamps being in same relative

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

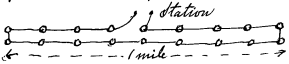
CABLE ADDRESS:
"EDISON NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

NEW YORK,

Subject.....

position, connected as below,



instead of using 100 Volt lamps taking one Ampere would take (as is usual in this system) 50 Volt lamps but taking two Amperes and same candle power as before. A circuit of 18 lamps makes 900 Volts and with only a ten per-cent loss equals a total 1000 Volts. The size of wire necessary for this loss equals between a No.18 and 19 and, to make resistance right, must take two-thirds No.18 and the rest of length in No.19. It is clear that in this case there is only two miles of wire necessary, making a total weight of copper of 72 lbs.

Therefore,

On the three-wire system at 15 per-cent loss, require, 1800 lbs. of wire
On Municipal System at 10 per-cent loss require, " 72 lbs. of wire.

this for lighting a street half a mile on each side of a station with the same candle power lamps and in same relative positions.

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diplome d'Honneur.

Adresse Telegraphique:
EDISON, PARIS.

Paris, le Oct. 14th 1885.

8, Rue de Caumartin.

Confidential.

Dear Mr. Batchelor,

I have received your letters of Sept. 24th and Oct. 2nd as well as the cable of Mr. Wallerstein relative to the fusion project, cable in which he says that Mr. Siegel has the power to sign any treaty, if it is in accordance with the Bailey agreement. The first thing I have to answer is, that it would have been much more simple and much easier for you, to change the Upton treaty in such a way as to make its terms equal for you to the Bailey agreement, and to send a document over to Mr. Siegel, who naturally does not want to take any responsibility for anybody in America, and who thus sticks to the letter, even if the sense would be the same in the words. This is just now the case; you remember the difficulties we would have had, if the Cie Continentale would have taken up the other two Companies, because the lawyers had are of opinion that the Cie Continentale could not make a new contract

ANNEX OF RECORD

with Mr. Edison, renouncing to the reimbursement of the capital, without the unanimity of the shareholders. We have, therefore, been obliged to turn the question in the following way: in letting the Société Industrielle and Commerciale take up the two others. But the Industrielle has but 3000 founder, and, even the profits being the same for the Light Co., I do not think that it would suit her to have but 1600 and some founder shares in the Paris Co. Besides that, the arrangement with other holders of founder shares would have been rather difficult, so we have decided to create 14000 founder shares and to give to all holders of founder shares one share in the new Co. and to the Edison Electric Light Co. of Europe (who, of the 8000 founder shares of the Bailey agreement would have received 6774 less 2270, or 4504) the same proportion of the 14000 founder shares, i.e. 7852.

Longwell will ask the different boards of the Paris Edison Co. to concede to the Light Co. those 7852 shares.

Besides that question I asked Mr. Edison to satisfy at once the German treaty, as you cannot deliver one penny of material in those countries as long as our Co. exist.

The German Co. would not sign the treaty if the Co. Continentale disappears, or the Light Co. would lose absolutely the 20000 marks. I cannot see the reason why Mr. Edison

puts these two things together, it seems to me a pure chicane and I write you all this confidentially to ask you very earnestly to do your best so that these matters should be settled at once, because I personally will not remain any longer in the Board, if these two questions, German contract and fusion, would not be settled finally in the course of next month.

Concerning the Canadian certificate you will have seen in our last letter to Mr. Edison that Mr. Pouillet is of the same opinion as Mr. Armengaud.

Yours very sincerely.

Louis Ravi

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

NOS. 92 TO 108 GOERCK STREET,

NEW YORK, Oct.14, 1885.

Subject.....

Western Edison Light Co.,

185 Dearborn St.,

Chicago, Ill.

Gentlemen:--

In answer to yours of Oct.1st, relative to transmission of power, would say that I prefer to do it by motors than by the means you suggest. Of course the cost of machines should be a little cheaper if you use two large instead of four small ones. In the case you give you propose to generate 400,000 Watts and recover 115,000 at the other end or about a loss of 71 per-cent. This would cost about,

2 or 4 Machines,	$6,500.
Copper about 35,000lbs.,	5,600.
	$12,100.

A better method I think is this:--

Generate at station 240,000 Watts by four machines of 1500 Volts and 40 Amperes in multiple-arc, lose 30 per-cent in line and get 1050 Volts in town. These four 1050 Volt motors drive four standard type 240 Ampere 125 Volt dynamos direct. Thus we generate 240,000 Watts and recover 120,000 in the town. The wire in this case would be about 10,000 lbs., $1,600. As each motor

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

NEW YORK,

Subject.....

Sheet No.2.

drives a generator in the town station they might be made on same base and thus be much cheaper. We might possibly make both armatures on same shaft, or at any rate coupled direct. The motor would equal in bulk a No. 12 machine but I think the motor and a No.12 together could be made for ~~$11,000~~, therefore the cost of this method would be approximately,

4 Generators,	$6,000.
4 Motor Generators,	7,000.
Wire about,	1,050.
	$14,050.

In the first place you draw about 600 H.P. from the fall and only utilize about 30 per-cent of it. In the second you draw about 350 H.P. and utilize about one-half.

Now it is a question for you to decide whether you can sell this 120,000 Watts for such a price that it will pay the investment dividend. You have here a plant with total capacity of 1,200, 16 C.P. lamps. In a station for 1,000, 16 C.P. lamps, as set up by the Edison Company for Isolated Lighting, the engines, boilers, piping, and dynamos cost $18,000. Transmission problems have not as yet been touched and we feel that the more they are stirred up the quicker we shall be able to get over the difficulties.

Truly Yours,

EDISON MACHINE WORKS.

Chas. Batchelor
Gen'l Mgr.

[ENCLOSURE]

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 to 108 GOERCK STREET,

NEW YORK, Oct. 12, 1885.

Subject Transmitting water power.

The following is a proposition for transmitting water power, three miles distant from a town centre as compared with that already proposed by the Western Edison Light Company. In their proposal they require two machines of 200000 Watts capacity each, or for 400 Amperes and 500 Volts, and running on three-wire system. Out of this 500 Volts they would get 115, a loss of 77 per-cent in the line and for this would want two No.00's (or equivalent in section.) for positive and negative wires and one No. 00 (all B.W.G.) for middle wire. The total weight of this for the given distance is about 35000 lbs. of copper, and horse power required from fall about 610. We propose to place at the fall four 1500 Volt Dynamos (each for about 40 Amperes) to run in multiple-arc and to lose 30 per-cent in line, getting 1050 Volts in the town. There, four 1050 Volt motors drive four 240 Ampere (standard type) machines making four mechanically independent sets. These eight machines will take up very little room, the motors being about the same size as the dynamos. The lamps are regulated from here (town), all the regulation from fall being to keep the 1050 Volts in town constant. The wire required to transmit this is a little smaller than No.0, which latter would be 11100 lbs., and with right size probably 10000 lbs. of copper wire, will be right. The rel-

this equals 5 70.

[ENCLOSURE]

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

NEW YORK,

Subject

ative size of all the twelve machines for this work will be just about the same as that of the two proposed large ones (500 Volt), though the Watt capacity is rather larger. As will be seen this method takes only 2-7 of the amount of copper required for the other one and horse power absorbed from fall is about 350 instead of 600. All power lost in machines is allowed for in these figures

It may be added that as the load may vary from two or three Amperes to the full amount, the Volts at terminals of the 500 Volts machines would have to vary from 115 to 500, or 77 per-cent from full. This would be very difficult to regulate by resistance in the magnet circuit and would have to be accomplished by varying the speed. In the case of the 1500 Volt machines, the Volts would only vary from 1050 to 1500 or 30 per-cent from full load to none. This amount of variation can be done by a resistance box in the field and keeping speed constant.

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de : Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diploma d'Honneur.

Adresse Télégraphique :
EDISON, PARIS.

Paris, le Oct. 26th. 1885.

8, Rue de Caumartin.

Mr. Charles Rutzebeck
New York

Dear Sir,

We beg to hand you enclosed our letter to Mr. Edison dated 26th. inst., and must ask of your Kindness to hand Mr. Edison that letter at your earliest convenience, in giving him eventually explanations should he require any on the matter, and in using that the power in question gets sent to us without any delay under registered cover.

Thanking you for your trouble

Yours very sincerely
Cie COMPAGNIE CONTINENTALE EDISON

Charles de Rosenthal

Encl.

— Bon pour pouvoir —

[ENCLOSURE]

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diplome d'Honneur.

Adresse Telegraphique:
EDISON, PARIS.

Paris, le Oct. 26th 1885.

8, Rue de Caumartin.

Mr. Th. A. Edison
New York

Registered

Dear Sir,

We beg to inform you that in 1882. the Faure Electric Accumulator Co of this city having introduced lamps & other material of the Edison system into France contrary to the Art. 32. of the French Law on Patents (of 1844) we were obliged to seize that material, and to that effect, the Patents being in your name, we had to deposit, also in your name, the sum of 1.000 francs as deposit-at-law, so to be able to begin proceedings against the said Compy. The Faure Co being in liquidation, we have now abandoned these proceedings, and in order that we should be able to recover the 1.000 francs which we deposited as above, it is necessary that you should sign the enclosed power authorizing Mr. Rousseau, our solicitor, to cash that amount for us.

enclosure.
Registered.

[ENCLOSURE]

Please do not forget to put, before signing, (in your own handwriting) the words: "Bon pour pouvoir", as indicated in pencil, and return us then signed, the enclosed document. For your guidance, we inform you that it is not required that your signature in this case should be legalized by a notary or French Consul.

Thanking you for your trouble

Yours sincerely.

1 document

COMPAGNIE CONTINENTALE EDISON

ADMINISTRATEUR DÉLÉGUÉ

SOCIÉTÉ ÉLECTRIQUE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique:
EDISON, PARIS

PARIS, LE Dec. 17th 1885.
8, Rue Caumartin

Mr. Charles Batchelor
214. East 18th Street
New York

Dear Sir,

We beg to acknowledge receipt of your two favors of Nov. 27th & Dec. 3rd, the contents of which we read with great interest and for which we beg to tender you our best thanks.

We request you to send us at once a hood cut out of the municipal system, to be able to examine his construction.

As soon as you will have the sketches of the dynamos of the municipal system, please do not fail to forward them to us, because it is urgent for us to make a trial and we think to use this system for some small towns not yet being lighted up by gas. — Give us also the dimensions of the carbon of the lamps.

We are in receipt of the samples of leatheroid & will make a trial with them; please accept our best thanks for having forwarded them to us.

A month ago we sent you

a full report of the Saint-Etienne Central Station. The plant is working very well, and to answer to the numerous demands for subscribers to the light, a double & even triple extension of the canalisation will be necessary. We are very much in hopes that the example of Saint-Etienne will be followed by other towns, Lyon, Marseille and Saint-Chamond. We are treating for the formation of Cos. in these towns. In order to hasten the formalities, we are these days addressing to Mr. Edison a demand of approval for the statutes of these future Cos., and we beg of you to kindly accelerate this approval, as it is important "to strike the iron whilst it is hot" & to profit of the good dispositions which the inauguration of the St. Etienne Station has brought about.

We are, Dear Sir,

Yours very truly,

SOCIÉTÉ ÉLECTRIQUE EDISON

A. L. Chatard

ADMINISTRATEUR-DELEGUE

[ca. 1885-1887]

Taylor. In this test of #4 as a motor driving #3 give me volts amperes & speed on the motor circuit & at the same time volts amp & speed on the #3 circuit

Also give me same in reverse case

Batchelor

[ATTACHMENT]

THOMAS A. EDISON, President.

CHAS. BATCHELOR, Treasurer and Genl. Manager.

EDISON MACHINE WORKS,

CABLE ADDRESS: "XYDSUN NEW YORK."

Nos. 92 to 108 GOERCK STREET,

New York,

Subject

No. 4 running as a motor driving a #3 dynamo. Started up, with no load except the belt and the #3 armature, with a very slight spark. The brushes were put at non-sparking point at each change of load.

Volts on motor	Speed	Amp. on dyn.	volts.
125	1500	0	0
125	1500	15	110
125	1540	63	110
125	1560	80	110

No 3 running as a motor driving a #4 dynamo. Started up with no load and sparked badly. Had the same amount of extra resistance in the field as it has with a full load as a dynamo.

Volts on Motor	Speed		Amp on Dyn.	Volts on Dy.
125	1560	100	0	0
125	1580	$7\frac{2}{24}$	15	112
125	1620		40	111
125	1635		63	112

[ATTACHMENT]

4.25 / 6.50 / 1.53
4.25
2250
2125
1250

8.75 / 10.50 / 1.2
8.75
1750
1750

11.25 / 1250 / 1.11
1125
1250
1125
1250

19.75 / 2200 / 1.114
1975
2250
1975
2750
1975
1750

13.625 / 15250 / 1.11
13625
16250
13625
26250

16.75 / 18.50 / 1.107
16.75
1750
1675
12500

0.92

2850
27.60

2 8 9 7 0 2
2 9 8 1
2 9 8 1
2 9 8 1
1 1
29.81

[ca. 1885-1887]

From line b b line a
coils c.c.c. have to a
change C from 77 to 80 Amp
Going the direction from 80 to 77

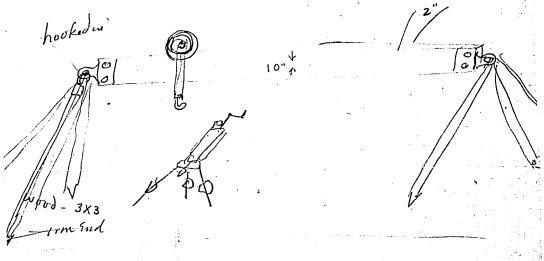
(Probably a 60 Pant Block
Machine)

With 80 Amp in coil self induc = say 1 V. = say 1 Block forward of neutral. Short coils take 1.03 Blk + long (slip rivers) + long .97 Block + in passing longest & shortest 2 dif. of .06 Block is reversed on bends.

[ca. 1885-1887]

Batch-

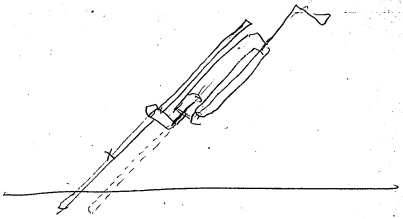
Dont forget about the 20 ft thing for handling drill ~~seq~~ that the 2 men running drill can put up easily —



I have an idea that with dry air we can do better by dry drilling than wet. if we can manage to blow dry the tool while wear at least 3 times longer = please see drill people + look at their automatic feed.

also if they will make a longer feed = ~~[illegible]~~ want a common boiler pump that pumps water to boiler also compress air ~~[illegible]~~ Let me know how you are progressing

Cant this be done



Drill rod at X outside instead direct in line with cylinder this would allow longer feed to drill by setting it forward

We have found 3 different parts where seamless steel tube can be obtained

Elissy

[ca. 1885-1887]

Batch –

Send over by Messenger Boy 4 doz No 16 or any other size sheet iron discs flattened & burned – I've got a dipping solution that dries instantly leaves a film say $\frac{1}{3000}$ thick that you may hammer or bend plate at right angles without breaking – dont shrink & stands 700 deg fahr without softening a boy can insulate 60 plates a minute & the moment he is through they are ready for assembling stuff is cheap. say 50 for an [illegible] will return you plates prepared – Yours E.

[ca. 1885-1887]

THE EDISON LAMP CO.,

East Newark, N. J., ... *188*

Batch =

Please inquire of Armengaud or your patent Lawyer if the importation of the Carbon loops alone would invalidate the main patent on the Lamp I mean the one patented in England in Nov 79 -

if not we could send you good Carbons by Express very cheap - We have just got up a new mirror gauge for gauging fibres but if you can import Carbons you will not need it 1/1000 of inch shows 2 inches on scale —

Edison

[ca. 1885-1887]

Form L. 1200-5-15-'88.

THOMAS A. EDISON,
No. 65 FIFTH AVENUE.

New York, ... 188

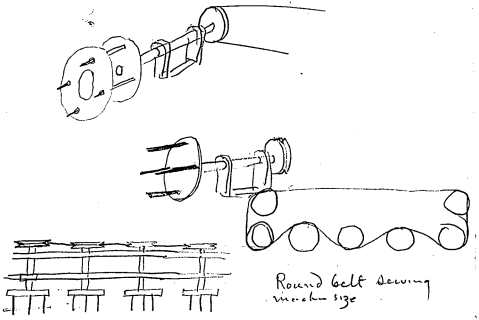
Butch = We tried that Ventilating once - it didn't do much good = you can blacken or partially Carbonize paper if you keep the heat constant at 275 Fahr its only a question of time - I sent a note two or 3 days ago to you also told Walter to hurry them up - I asked for 50 armature iron plates. Can't you arrange with some one in work to attend to such things. There's terrible waiting for things from South takes the enthusiasm clean out of me = I have a substance you can dip plates in & it dries at once & stands 700 deg Fahr easily without Carbonization, you can hammer it - The only solution of Focault currents is 6/or 8/1000 from & the sooner we get

Thus the better 8/1000 will give you a comparatively cool armature 6/1000 would allow you to put 33 pct more lamps on dynamo with no more danger than now with 12/1000 — The moment you figure the heat in the iron due to Eddy & Res you see where the heat comes from — it's strange that we dont get more heat — you could afford to pay 3c more per lb for 6/1000 — Walter says paper occupies 33 percent of whole armature, this substance I have want occupy more than 6 pct & is far better, this will prevent armature from saturating & give you still greater output — allows you to put a larger field on same armature — If you will have some one take these matters up & attend to them safely it will be a good thing all round — E

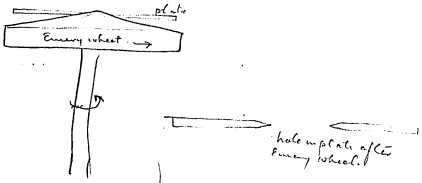
[ca. 1885-1887]

Batchi

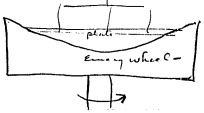
I will make up the Solution and will send by Express; it requires about 2 @ 3 days to make one gallon will be plenty I have Experimented a great deal to get it on Even There is only one way to do it you will have to rig up



Regarding the burring of the plates — after flattening them in a press I proposed to make an Emery wheel thus



If outside edge needs it then use emery wheel thus



70 | 40000 | 570
350
500
490

75 | 40000 | 533
375
250
75

533
533
586

Speed about 65 @ 75 per minute - after dipping quickly put it on the taper pins so it will stand straight & not wabble - & let it run till dry - it will coat it perfectly - ~~pay~~ perhaps you could get up a simpler one

it takes about ~~[illegible]~~ 1/2 to 3/4 minute to dry thick coating - Its dissolved in Bisulphide Carbon so cook out no fire gets near -

you might put several plates even 20 plates on one set of prongs not making them taper & letting plates be 1/2 inch apart. The only essential thing is that they must be rotated

Edison

If solution too thin it will evaporate down by steam or you can thin it by adding Bisulphide Carbon

CHARLES BATCHELOR COLLECTION

1886

B. Twiss

Erastus Wiman

ERASTUS WIMAN, President.

H. P. DWIGHT, General Manager.

THE GREAT NORTH WESTERN TELEGRAPH CO.

OF CANADA,

OPERATING THE LINES OF THE MONTREAL, DOMINION, AND MANITOBA TELEGRAPH COMPANIES.

President's Office:
314 Broadway, New York.
P. O. Box 737.

NEW YORK, JANUARY 18TH 1886.

C.BATCHELLOR ESQ.,

214 EAST 18TH STREET, CITY,

MY DEAR BATCHELLOR:-

I AM VERY MUCH OBLIGED TO YOU FOR YOURS OF THE 16TH IN WHICH YOU ACCOUNT FOR THE BALANCE, $116.67, IN THE SHAPE OF A CHECK DUE ON WILLIE'S ACCOUNT. I AM VERY MUCH INDEBTED TO YOU FOR YOUR CONSTANT COURTESY TO HIM AND FOR THE OPPORTUNITY YOU GAVE HIM TO LEARN SO MUCH AS HE DID. I AM ALSO OBLIGED FOR THE LETTER YOU GAVE HIM AND FOR MR JOHNSON'S ANXIETY TO PUSH HIM FORWARD. I THINK ,HOWEVER, IN THE TELEMETER COMPANY HE MAY DO SOMETHING ON HIS OWN ACCOUNT . AT ANY RATE, I HAVE MADE THAT CHANGE IN HIS DESTINY.

IT IS A GREAT PLEASURE TO BE ASSOCIATED WITH YOU AND OTHER GOOD FRIENDS ,WHO ARE SO READY TO RESPOND TO ONE'S REQUESTS

FAITHFULLY YOURS

Erastus Wiman

[INCOMPLETE] [FROM LOUIS RAU?]

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de 1 million de francs
Exposition Internationale d'Électricité
Paris 1881
GRAND DIPLOME D'HONNEUR
ADRESSE TÉLÉGRAPHIQUE
EDISON, PARIS

Paris, 12 Mr. February 1886

8 Rue Caumartin

Charles Batchelor Esq.

New York.

Dear Sir,

We beg to hand you enclose copy of our letter to the Light Co. of Europe of New York.

We will be much obliged to you if you, on your part, will also impress on the managers of said Company, that if they desire the prolongations for the full term of the principal Italian patents of Mr. Edison, they must put themselves first in accord with the Italian Company at Milan, who defrays all expenses connected with these patents & without whose consent nothing can be done in the matter. The patents stand in our name, but we follow alone the instructions of the Italian Company, as we are bound to do by the contract, duly ratified by MR. Edison & the Edison Electric Light Co. of Europe.

By trying to obtain the said prolongations, by applying directly in their own name to the Italian Government the Managers of the Light Co. only create difficulties & a confusion which might have consequences for which they are answerable.

It is their own interest now to follow exactly

Copy.

THOMAS A. EDISON,
PRESIDENT.

(Form 21.)

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

Nos. 92 TO 108 GOERCK STREET,

CABLE ADDRESS:
"XYDSUN NEW YORK."

New York, Feb. 24, 1886.

Wound a #8 with same wire as usual only made 88 Commutator blocks and one loop per block instead of 44 blocks and two loops per block. Other things same as regular #8. Armature ran well considering that a "High bar" came up after running a little. All sparking could be gotten by moving brushes. Temperature of armature was rather high but run was for six hours. Small size of cups and bars probably the cause. Increase was 61° C. Armature was wanted to send off so could not run it again after commutator was turned off. ~~Sxxxxxxxxxx~~

Several Conductivity tests have been made lately results as below:--

Conductivity of some Ansonia Copper wire gave a mean of 98% tho' two of the samples came up to 99 & 100.

Conductivity of some Iron & Copper (about 90% Cop) & Tin & Copper gave 34% conductivity for the Copper & Iron & 16% for the other.

Conductivity of brass used for rings of ~~palting~~ la machine is 21% only.

Conductivity of a copper zinc casting 96% copper & 4% zinc, gave 43.6% for both samples. Length tested 6" Weight

Feb. 25, 1886.

Particulars of recent saturation curves made as follows:--

The curve on the #20 (Jan.21) is at a speed of 800 (Av)

The curve on #1 (Feb.2) is at an average speed of 1750. To read amperes divide by two as magnets were connected in multiple arc to make test.

The curve on #2 was taken at the same time as the #1 and under same conditions only the speed was 1960 (average),

350

1400
1/2
23.6

Cie CONTINENTALE EDISON
SOCIÉTÉ ANONYME
Au Capital de : Million de Francs

Exposition Internationale d'Électricité
PARIS 1881
Grand Diplome d'Honneur.

Adresse Télégraphique :
EDISON, PARIS.

Paris, le March 2nd 1886

8, Rue de Caumartin.

Mr Charles Batchelor
214 East 18th St
New York

Dear Sir,

We beg to acknowledge receipt of your favor of Feby. 4th and, according to your instructions, we handed over to Messrs. Drexel Harjes & Co. of our city, the different shares we have had in deposit, viz.

two shares of the Cie Continentale
ten shares of the Société Electrique &
ten shares of the Société Indust. & Com.le,
which please take note of.

Yours very truly
COMPAGNIE CONTINENTALE EDISON

[signature]
ADMINISTRATEUR DÉLÉGUÉ

(1292-K.

Compound

No.

EDISON MACHINE WORKS,

TESTING DEPARTMENT.

New York, Mch 6th 1886

Report of Machinery Test

Class Telegraph, Dynamo No 1 Armature No. 1

Duration of Test 4 hours, 30 minutes.

Ran for ..... hours 30 minutes, with 150 Volts ..... Amperes,

Speed 1600, Extra Resistance in Field ..... Ohms.

Continued 4 hours, ... minutes, with :- 150 Volts 40 Amperes.

Speed at beginning of 2nd hour, 160, Extra resis. in Field 37.5 Ohms.

Speed at end of Test 1600, Extra Resistance in Field 36 Ohms.

Magnet Resistance, Cold ..... Base ..... Hot 107.7 Base Meg.

Armature Resistance, Cold 122 Base, Meg, Hot 146 Base Meg.

Temperature of Magnets, Cold ..... Hot .....

" " Armature, Cold 18° Hot 54° 57° 60° 58°

" " Room near Dynamo, Starting ..... Ending 18°

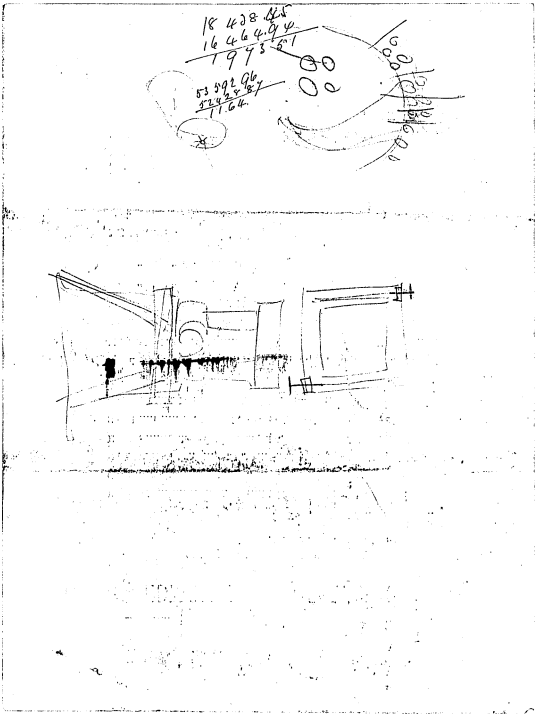
REMARKS:- Iron Pulley 8½ x 5

25 Ohms
gas plug 5 cal
4 plugs

Signed F. E. Fitzgerald

Approved

H. K. BROWNE.



THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

8005

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 to 108 GOERCK STREET,
NEW YORK, March 8th 1886

Subject.

Chas: Batchelor Esq.

Dear Sir

I enclose a sketch of method of connecting special "3" (150 V) I tested Saturday. It ran very well with no sparking, and no shifting of brushes beyond the rocker-arm. Being rather high in saturation, the regulation is not so good as it might be, but the number of turns of series field were exactly right. The volts were – taking no load at 148.5. Then at half load they would be 151.5, and at full load 150 Volts so the mean is exactly right.

The experimental #20 ran badly as far as sparking but I ran the test for heat. I found out from Hammer that he has connected it wrong and this

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

NEW YORK,

Subject.....

has of course caused the sparking. I will explain the mistake tomorrow. It is an important one.

A #1 can be wound for 200 Volts + 1500 Revs. = 1# 18 (B.W.G. .049) twelve times round + 44 Cont^n Blocks. A.M. 6% more than on St^d #1.

Iron core $\frac{1}{16}$" (.0625") less dia: or .03125 on ea: side off. Field = # 22 (B.W.G.) same # of lbs: as on St^d #1. About 20% extra res: in field. Same bore. Res: about .62 ohms.

Yours Faith^ly
Henry E. Walter.

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

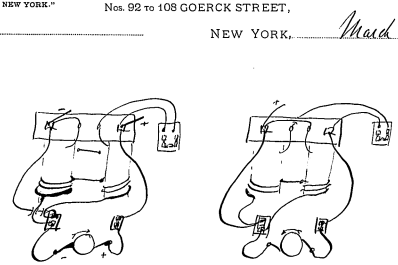
EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

Nos. 92 TO 108 GOERCK STREET,

NEW YORK, March 8th 1886

Subject



Method of connecting series and shunt coils for different directions of Armature. Attach wires (of series field) to left hand fuse plates. Then if the left hand brush is the upper one left hand wire goes on lower plate. If brush is lower one, then connect right hand wire to lower plate of fuse board.

A.L.W.

Have diagram
made of connection
of 400 amps
when connected
½ block out +

Washington, D. C. 3, 13, 1886.

Charles Batchelor,

214, East 18th St. New York.

My Dear Mr. Batchelor:

Yours of 3, 8, came duly to hand, and I have since been trying to get the Report of Genl. Abbott on the Fish Torpedo, but have not up to this time succeeded.

The Report that he has made is only a preliminary one, and is regarded as confidential by the Chief Engineer, who has placed the injunction of secrecy on it, and will not allow anybody to see it, except those in direct connection with the experiments.

If it is of any special importance to you, or you must have it, I shall have to find some way to break through the barricades, and take the chances of incurring the ill will of the Bureau, should they find that it had been got away from them.

Genl. Abbott has been ordered to move his headqrs. from Willets Point to New York.

Yours truly,

W. H. Parker

[INCOMPLETE] [FROM CHARLES BATCHELOR?]

(Form 31.)

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L. MANAGER.

EDISON MACHINE WORKS,

Nos. 92 to 108 GOERCK STREET.

CABLE ADDRESS:
"XYDSUN NEW YORK."

New York, March 13, 1883.

Richard N. Dyer, Esq.,
65 Fifth Avenue, City.

Dear Sir:--

I understand that you are having drawings made for the new motor of Edison's in order to forward them to a committee in regard to the system. It may therefore not be out of place for me to give you a few points as regards the general distribution and working arrangements of the motor as we have driven it on the short railroad line at the station at 24th street.

As our drawings will show you, the motor is designed to run at about 550 revolutions and driving by a steel chani on each side a sprocket wheel on each end of one of the axles of the truck. The speed of the car wheels is about 225 revolutions for twenty miles an hour. This is considered as the maximum at which these cars would need to run. The motor drives these steel chains by what is known as the Weston clutch. The Weston clutch, one at each end of the shaft, is operated by a vacuum cylinder under the car. The vacuum cylinder is exhausted by a pump on one of the motors and the arrangement of pipes, the inlet and outlet, the pulling diaphragm, brakes and the Weston clutches is substantially the same as the Eames Vacuum Brake people now put on to railroads with the exception that we make our vacuum by pump and on the ordinary railroad they make it by steam injection.

Each motor is compound wound but the current in the series field is in the same direction as in the shunt field. The object of the series field is to prevent the current being to heavy in starting. It gives a back E.M.F. due to suddenly increasing the magnetism in the cores and also its own self induction This has very short duration and the difference between starting with or without the field is very marked, there being comparatively little sparking with the series field in the armature circuit whereas without that the sparking is very heavy. The series field itself does not of course help as a resistance as it is only about one-third that of the armature. The self induction of the armature is of very short duration, the armature itself being composed of thin iron discs. That sudden starting of the armature does not spoil the commutator is proved, the motors having been started and stopped several hundred times without appreciable effect. As the shunt field nearly magnetizes the field to saturation, the series field has not much effect in reducing the speed when there is any load on the motor. There is a similar motor on each truck both of them running in multiple are across the line. In figuring out these motors we found that a loaded car

THOMAS A. EDISON,
PRESIDENT.

CHAS. BATCHELOR,
TREASURER AND GEN'L MANAGER.

8152

EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

NOS. 92 TO 108 GOERCK STREET,

NEW YORK, March 26th 1886

Subject

Chas: Batchelor Esq.

Dear Sir

The figures for the "Wenstrum" Dynamo, do not agree very well. As far as I can make out there are only 25 Comtr Blocks + 25 Divs: + also 1 #(.100") 12 to 13 Bkg. 6 times round + this for 100 Ampères This makes only 200 Circ: mils per Amp: The "Intensity" is very low if the above is right = .12 or about 1/3rd that of the Std Dynamos. That of the core (magnet) .276 whilst on the #20 it is .96! If the discs he gave me is right then I do not see how he can get 50 Comtr Blocks + 1 wire 6 times round.

Yours Faithfully Henry E Walker

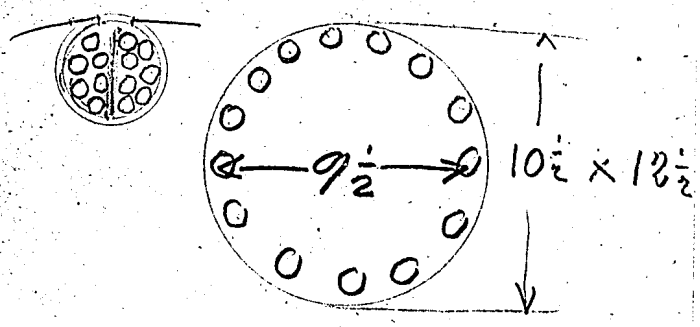
[ATTACHMENT]

660 rev
60 volts
100 amps

When magnet in multiple arc
mean speed of wire 500 ft

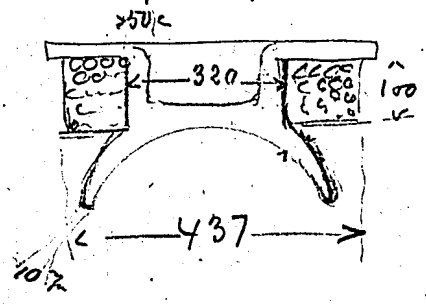
When cores in series
1200 rev
110 volts
100 amps

mean speed of wire 900 ft



50 div: 50 com: bl

1 (# 12 a 13 B.W.G.) = 2.55 m/m 6 times round
total length of wire 350 metre



1700 metre on each magnet
1.7 m/m diam (# 15 a 16 B.W.G.)

THOMAS A. EDISON,
PRESIDENT.
JOHN KRUESI,
ASSISTANT GEN'L MGR.

CHAS. BATCHELOR,
TREASURER AND GEN'L MGR.
SAM'L INSULL,
SECRETARY.

THE EDISON MACHINE WORKS,

CABLE ADDRESS:
"XYDSUN NEW YORK."

NOS. 92 TO 108 GOERCK STREET,

Subject Winding. NEW YORK, March 31st 1886

New Winding for #20 Armature.

Armature dia (Core) = 12.75" dia + 12.375" level.

Winding = 4 # 8 (Blog. .165") once round + 50 Com^tor Blocks. .

Outside dia .03125" larger than at present.

"Vertical" Winding.

H.E.W.

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EDISON MACHINE WORKS,

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Nos. 92 TO 108 GOERCK STREET,

Subject Experiment. NEW YORK, March 31st 1886

Experiment on #4 Armature.

Interspersed Iron.

Make Armature 7.125" dia; extreme and cut 6 places for wire bands $\frac{3}{4}$" wide + $\frac{1}{32}$" deep.

Cut 50 longitudinal slits .2" wide + .73" deep from extreme dia.

Winding 1#9 (Bldg. .148) twice round + 50 Cont^n Blocks. + ordinary (not vertical) winding

H.E.W.

OK

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Nos. 92 TO 108 GOERCK STREET,
NEW YORK,

Subject Low speed dynamos. March 22nd '86

Low speed Dynamos. Approximate Sizes.

110 V.	20 A	1700 R.	Can be reduced as by figures given previously. Or a #1.
110 V	40 A	1500 R	" " Or a #2
110 V	60 A	1200 R	Want a #4. Watts = 75/60
110 V	80 A	1200 R	" #6 " = 120/88 This wd be too large perhaps can alter #4 by cores.
110 V	120 A	1000 R	Want a #8 Watts = 14/13
110 V	160 A	800 R	" #12 " 20/17.5
110 V	200 A	600 R.	" #16 " 24/22
110 V	240 A	500 R	A #20 = 312/264: this will take a size between #16 & #20.

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Nos. 92 to 108 GOERCK STREET,
NEW YORK,

Subject Low speed dynamos. March 22nd 86

110 V 320 A 400 R Takes a size ½ way between the #20 + 500 Amp (new).

110 V 400 A 400 R Takes sizes of new 500 Amp in watts × speed = $\frac{457}{440}$.
= a 500 Amp

A.E.W.

160
500
80000

2200
1550
650

400
110
44000

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Nos. 92 TO 108 GOERCK STREET,

NEW YORK, March 24th 86

Subject Telegraph Dynamo

For shunt (or fine wire) field.—

Connect inside wire of right hand magnet to under brush, whichever way the armature is going, as shown in sketch

For series (or thick wire) field:—

Connect two inside wires - together with a connector. and the two outside ends one to each plate of left hand fuse plates.

If the armature is going in the direction of the hands of a watch (looking from the comm^tr end) cable from right hand magnet goes to lower plate + if armature is going in the reverse direction, the latter cable goes to upper plate. The cable always connecting to the remaining plate.

HEW

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Nos. 92 TO 108 GOERCK STREET,

NEW YORK, March 26th 1886.

Subject

Experimental Armature (Dynamo Motor).

A # 4 Armature. For 500 V + 15 A + 110 V + 60 A.

Core 6" dia (1/4" smaller than regular)

1 Level 5.75". Wind 1st with 2 # 14s (B.W.G. .088")

Twice round and vertical winding =

+ 40 Contr Blocks. (Plenty of room in circumference).

Wind 2nd with 1 # 16 (B.W.G. + .015" ins: .065") 9 times

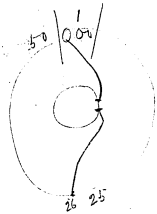
round + 40 Contr Blocks. Also vertical wd eq =

This is wound from the other end of armature.

Wt. of wire 1st = 11 lbs 2nd = 17 lbs. Res 1st .050 ohm 2nd .82

Speed 1600+.

H.W.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THE EDISON MACHINE WORKS,

CABLE ADDRESS:
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NOS. 92 TO 108 GOERCK STREET.

Subject 79 Heating effect of current in armature of a

NEW YORK, May 12, 1886.

~~Experiment on heat of~~ 16 made May 4th last.

Armature still and magnets charged in opposite directions. Current put thro' armature by the regular brushes. In this way we get the heat of both armatures and magnets without any of the heat due to the iron core. The temperature ~~it rose to was~~ probably ~~be~~ 33% higher than it would have been if the armature had been revolving rapidly and fanning the air. Test was made on 16 #13, 125 Volts on magnets with 3.4 Ohms in series (Mag. res. 23 Ohms) and 336 Amperes for four hours. Temperature 72 C. ~~after~~ 20 minutes, was taken on the ~~as~~ thermometer was wanted for the other armature. Besides the four hours run on regular load the armature had, as well as the other armature running giving the current 16 #14 Temperature 83 C), 380 Amperes for ½ hour then about 180 for ½ hour then 400 Amperes for ½ hour. Then there came the four hours run. Temperature of room was 22.5 C. Increase was 49.5 C. Commutator was rather hot.

On the same day a test was made on the "Long shaft" 12 iron core, covered with two layers of paper and tape. Only ran 2½ hours intermittently as tape always came off a ter running a little while, not being tied on well. Temperature of room 20 C. Armature 40C on tape; though half and hour afterwards was 44C on irno core itself. Probably 50C when shut down. The above test cannot be taken as any good result and armature was let go only because it was necessary to rewind it as quickly as possible.

H. E. W.

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Nos. 92 TO 108 GOERCK STREET,

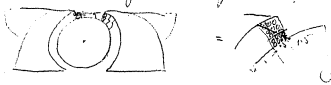
NEW YORK, May 12th 1886

Subject

Transformer:-

There is a difference of 5% in E.M.F. (comp.) of the two sets of coils. Or 5% more lines cut by outside coil. This is with inside (thick wire) coils as a motor and no load.

With a load of 50 Amp. on motor = 110 V. there is no difference in comparative volts. the generator giving 532 V. including drop. and about 9-10 Amp. Motor moved backwards ½ a block about. Dyn. brushes kept constant. The explanation is very probably the following.



H.W.

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NOS. 92 TO 108 GOERCK STREET,

NEW YORK, May 12th 1886

Subject

Unipolar Machines:—

Weight of present plating machine = 3050 lbs with the 1" pole-pieces instead of the 1½". (Rif. = 40± lbs). Ampere turns to give 9 Volts = saturation = 15,000 Ampere feet = 75,000 Or #20 Amp. turns (to about sat.) 20,000 Amp. feet = 95,000. But taking only ½ as effective = 47,500. Or ρ (the magnetic res.) = 1 : 1.5 in #29 : Amp.

For a 60 Volt and say 400 Amp. want 24 rings. Each ring about .15" wide and of copper and then brass sides total .3". Inside brushes of wire & curved.

H.W.

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Nos. 92 TO 108 GOERCK STREET,

Subject

NEW YORK, May 12th 1886

Experiment on heat of "16" made May 4th last.

Armature still and magnets charged in opposite directions. Current put thro' armature by the regular brushes. In this way we get the heat of both the armature and magnets without any of the heat due to the iron core.

The temperature is rose to will probably be 33% higher than it wd have been if the armature had been revolving rapidly and fanning the air. Test was made on "16" #13. - 125 Volts on magnets with 3.4 Ohms in series (Mag. res 23 Ohms) and 336 Amperes for 4 hrs. Temp: 72° C. after 20 min: as thermometer was wanted for the other armature. Besides the 4 hrs run on regular load the armature made

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Subject

, as well as the other armature running giving the current ("16" = 14 Temp. 83 °C.), 350 Amp for 1/4 hr then about 180 for 1/2 hr then 400 Amp for 1/4 hr. Then then came the 4 hrs run. Temperature of room was 22.5 °C. Increase was 49.5 °C. Comtr was rather hot.

On the same day a test was made on the "long shaft" 12 iron core, covered with 2 layers of paper & tape. Only ran 2½ hrs intermittently as tape always came off after running a little while, not being tied on well. Temp of room 20+ °C. Armature 40+ °C. on tape; tho' half an hour afterwards was 44° on iron core itself. Probably 50+ °C when shut down. The above test cannot be taken as any good result and armature was let go only because it was necessary to rewind it as quickly as possible.

HEW.

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NOS. 92 TO 108 GOERCK STREET,

NEW YORK, May 13th 1886

Subject

Plating Exp: —

With a density of current of .175 Amp: per sq: in the plating is good but the drop in Volts in the solution at ½" distance was .7 Volt: At .75 Amp: per sq: in the plating was bad, and the drop was about 2 Volts: same conditions as before. Copper deposited by first experiment was about 18 grammes per hour per amp: At this rate 1 ton (2000 lbs) of copper we take 730 H.P. hours or 30 H.P. for 24 hrs. (a little more than the capacity of the plating machine at 9 V + 2000 Amp).

As a large refinery in Germany from various data I arrive at the following. They use 27 Volts on 120 tanks in series each tank having 15 sq: in surface. Their drop is only .2 Volt per tank

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Nos. 92 TO 108 GOERCK STREET,

NEW YORK.

Subject

using about 300 Amperes, but they deposit at the rate of only $\frac{1}{13}$th that we deposited here at, or a density of current of ·0235 Amp. per sq. in instead of ·175. They give their distance as 2 to 10 cms. but they probably heat their solutions to get lower res. 50° C. as the same specific gr. gives 25% lower res. & therefore drop. Their rate of deposit per ampere is the same practically as our own tests = 1.18 grammes to 1.1 gr.

They deposit 900 kilog. a day = 1 ton with 11 elect. H.P. Therefore a ton takes 264 H.P. hours.

At this rate the plating machine wd do 2½ tons.

H.W.

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CABLE ADDRESS:
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NOS. 92 TO 108 GOERCK STREET,

Subject Compound Dyn: NEW YORK. May 18th 1886.

40 ohm
8 lbs

0600

Constant Potential "1"

for 108 Volts 20 Amperes + 1800 Revs:

Armature regular standard type.

Field:—

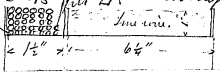
Cores = 8.625" (8 ft) length and 5" dia.
as given before.

Winding:— 36 lbs of #22 (Bbl. .028")
+ 10 lbs of #7 (Bbl. .18").

18 lbs of #22 on each core on upper part
and 32 turns of #7 on lower part as in sketch.

Res: = .191 ohms for fine wire and .033 ohms thick.

Hh. = .15 per □". Thickness of wire on cores 1."



+ 10% extra resistance. H.E.W.

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EDISON MACHINE WORKS,

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Nos. 92 TO 108 GOERCK STREET.

Subject Dynamo

New York, May 20th 86

Magnets:—

Cores = 15" long (same as compound marine "4") + 7.375" dia.

Winding 130 lbs of # 22 (Dia. .028") = 720 ohms
Extra res: about 30% of field or 25± % drop.
Current thro field = .64 Amp. Ht. per sq: in .25
on "4" = .24.

H.E.W.

(Figures not yet verified. HEW)

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CABLE ADDRESS:
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Nos. 92 TO 108 GOERCK STREET.

Subject Dynamo

New York, May 20th 86

Municipal Dyn: for 4 circuits of 10 (32 C lamps) ea: = 12 Amperes and 600 Volts. This allows 100 Volts for loss in line, or as much as is allowed at present on 1000 Volt machines; altho' efficiency is not quite so much.

Machine - all mechanical parts a #4 std: type Armature core same and box same.

Winding = 1 #17 (Bwg. .058") 6 times round T 76 Cont^n Blocks tho' only 38 divisions. =

This winding gives about 1/16 more room for ins. on each side (of dia.) I = .385 = 5% higher than #4. Wt. of wire = 16.5 lbs. Res: = 1.23 ohms.

H.U. per □" = only .56 (very low) On 4 = .9 tho' on Mun: #1 = .58.

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EDISON MACHINE WORKS.

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Nos. 92 TO 108 GOERCK STREET.

Subject Dynamo

New York, May 20th 1886.

Dynamo for 350 Volts and 16 Amperes. 1600 Revs

Take a regular #"2" Armature core and wind 1 # 16 (Bkg. .045") 9 times round and 56 Cont^s Blocks (same as usual) = .

Ht. = 1.8. On #2 = 1.04, but this keeps quite cool. Speed can be 1600 rev's. And current this field same as for regular 2 = 1.9 Amp.

Extra res about 60 ohms. Had better be made to 100. C: at 60 ohms in = 1.9 Amp.

Field magnets same as regular "2".

H.W.

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THE EDISON MACHINE WORKS,

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NEW YORK.

Subject: Dynamos. May 22nd 1886.

It is very probable that a change of ratio has occurred in all the dynamos when the extra 5 sheets of paper were put in between every 5 iron discs, and this could probably make the section of the core 10% less. As this core is pretty nearly saturated this would affect the current necessary thro' the field.

The % of section that the iron plates are of the iron core (magnet) is only 76·3%. This neglects the stuff. Taking this there must be a saturation ·94 (= core I) × $\frac{100}{76.3}$ = 1·24 "I"! And this not yet saturation.

H.W.

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THE EDISON MACHINE WORKS,

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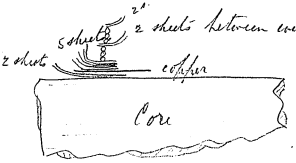
Nos. 92 TO 108 GOERCK STREET,

Subject Dynamo NEW YORK, May 22nd '86

For Municipal #1 Magnets:—

Wind 160 lbs of # 22 (B.W.G. .025")
or 80 lbs on each core. Res: 850 ohms.
Insulation =



H. Ew.

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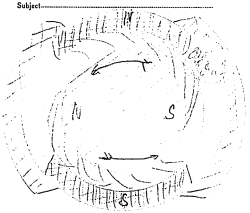
Nos. 92 TO 108 GOERCK STREET,

NEW YORK, May 22nd 86.

Subject



Exaggerated diagram.

If brushes be not moved when armature is stronger than the field as the armature mag: > field mag: they will spark badly as neutral point will be about 45° away from starting point. Any magnetizing or rather demagnetizing coils to distort the field back again, can hardly work well when the armature is as strong as the field, and there may be two neutral points. At 600 speed the I on motor is ·28 about at 50% eff: but at 1200 it is only ·14. And the arm: with about 20,000 ampere turns would give most probably more than ½ thus the field giving the remainder. As a fact at 40 Amperes it has 23200 Amp: turns.

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JOHN KRUEB, ASSISTANT GEN'L MGR.
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1500 0000 600
2 2 3/4 5

12 00

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NOS. 92 TO 108 GOERCK STREET,

Subject..... NEW YORK,.....

Ampere turns on "12" = 6,000. Sprague at 40 Amp = 25 H.P. about effective = 4 times this.

Sprague also has only $\frac{1}{4\frac{1}{2}}$ of the magnetism (.14 : .64 at 58%). Or this would be equivalent, in sparking to 18 times a #12. Or running a #12 as a motor on 400 effective H.P. by putting 6,300 Amperes thro' it and a drop in Arm of 62 Volts (wasting in heat 500 H.P.).

H.E.W.

P.S. Self induction merely is as 1:2 only allowing for difference in cont^n blocks.

H.E.W.

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EDISON MACHINE WORKS,

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Nos. 92 to 108 GOERCK STREET,
NEW YORK.

Subject Dynamos (Low speed) May 25th '86

A #16 Machine for 160 Amp: (200 lb) and 125 V. (110 V) @ 500 Rev's, can be made :-

Armature :- Wind with 2# 9's (Bias .148") twice round + 48 Comtr Blocks (or once round and 96 Comtr Blocks). Magnets the same which would give 125 Volts. Armature about 1/8" larger dia: tho' this is not necessary.

Or if can do with 160 lights = 120 Amperes a #12 with no change on Armature at all except winding 1.199" twice round (instead of 2 once round). Field would have to be the next sized larger wire, and this for 110 Volts. H.W.

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Nos. 92 TO 108 GOERCK STREET,
NEW YORK,

Subject Municipal Dyn: May 26th 86

Municipal #1 Armature :-

To increase dia: of armature in order to lessen distance from core to field:-

Taking insulation of wires at ·02"

Japan	·002
Dia. of wire (6)	·39
Ins: of "	·12
3 papers (on core)	·012
5 " between wires	·02
Tape	·015
Mica and wire	·052
	·611

× 2 = 1·2" (1·19 = 1 3/10)

Make armature core 7·4375" = 7 7/16

Outside dia 8·625" = 8 5/8

Bore allowing 1/8" clearance - 8 7/8 = 8·875 HEW

Bore is now 8 7/8. v.

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Nos. 92 TO 108 GOERCK STREET,

NEW YORK,

Subject

May 27th 1886.

Shunt Dynamo for 135 Volts and 500 Amp:
800 Rev's :—

Armature 26" length and 15.375" dia
14.875" at bevel ($\frac{1}{4}$" ea: side for bevel).

Winding 4# .199's vertical (on a round)
= . + 50 Comtr Blocks. 8 blocks cut
out = 7.5". Outside dia = 16.375". Bore = 16.7".

Field same as #20 regular also
the winding.

(I on core .9).

S.H.E.W.

(Rough Figures only).

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EDISON MACHINE WORKS,

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Nos. 92 TO 108 GOERCK STREET,
NEW YORK, June 12th 1886

Subject: Experiments :-

Experiment on Compound Dynamos.

Made on a "4" with Marine dynamo cores.

Set volts at 110 volts and no load. Then, with full load and brushes in same position (as at no load), the volts were 111. And with brushes moved to non-sparking point volts were only 106 - a difference of 5. Again: tried only one coil with a series field (coil (1)) with 50% more turns on it than it had before, tho' 25% less turns than the total before. With this arrangement the movement of the brushes was about the same as before. And it was also about the same with (2) in circuit but in reverse direction.

Henry E. Walker

THE STATEN ISLAND
RAPID TRANSIT RAILROAD COMPANY.

Incorporated April, 1884.

DIRECTORS:

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MANAGING DIRECTOR—ERASTUS WIMAN, N. Y. NIMS, Second Vice-President B. & O. R.R. Co., Baltimore, Md.

E. J. D. CROSS, Assistant Counsel B. & O. R.R., Baltimore, Md.
D. H. HAYES, President B. & O. Telegraph Co., 23 Broadway, New York.
JAMES M. DAVIS, Banker, Exchange Place, New York.
JOS. SCOTTON, Director Louisville & Nashville R.R. Co., 52 Exchange Place.
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G. S. RENWICK, Gen'l Agent B. & O. Express Co., 57 Broadway, New York.
H. HOLTON WOOD, Whitehall Street, New York.

ERASTUS WIMAN,
President of The Staten Island Railway Company,
314 BROADWAY, NEW YORK.
P. O. BOX 2613.

NEW YORK, JULY 19TH 1886.

C.BATCHELOR ESQ.,

LONG BEACH HOTEL, N.Y.

MY DEAR SIR:-

IN REPLY TO YOURS OF THE 14TH INSTANT, I HAVE SIMPLY TO SAY THAT I THINK THE SECOND MORTGAGE BONDS OF THE STATEN ISLAND RAPID TRANSIT RAILROAD COMPANY, GUARANTEED BY THE BALTIMORE AND OHIO, ARE THE BEST SECURITY NOW OFFERED. THE RAPID TRANSIT RAILROAD ITSELF IS ALMOST A PHENOMENAL SUCCESS. IT IS A ROAD THAT CANNOT BE COMPETED WITH, AND, DEPENDING AS IT DOES ON THE SUBURBAN TRAFFIC OF A CITY THAT CANNOT HELP BUT GROW, ITS ABILITY TO PAY ITS INTEREST IS UNQUESTIONED, EVEN UNDER EXISTING CIRCUMSTANCES, BUT WITH THE INCREASED TRAFFIC WHICH THE BALTIMORE AND OHIO IS TO BRING TO IT, IT IS SURE TO SHOW A GREAT EARNING POWER ABOVE ITS FIXED CHARGES. THE B. AND O. GUARANTEE, OF COURSE, RENDERS IT UNDOUBTED, THOUGH THE CERTAINTY THAT THE LITTLE ROAD WILL EARN ITS FIXED CHARGES IS JUST AS GREAT AS THE CERTAINTY THAT THE BIG COMPANY WILL EARN ITS CHARGES, AND EVEN GREATER. I CAN STRONGLY RECOMMEND THIS INVESTMENT TO YOU BECAUSE OF MY FULL KNOWLEDGE OF ALL THE CIRCUMSTANCES.

SHOULD YOU BE DISPOSED TO TAKE A FLYER IN A SMALL ENTERPRISE MORE OR LESS BOUND UP IN THE OTHER I DIRECT YOUR ATTENTION TO THE ENCLOSED

FAITHFULLY YOURS

Erastus Wiman

Catch-Patents

SOCIÉTÉ ÉLECTRIQUE EDISON,
SOCIÉTÉ ANONYME
Au Capital de 1 Million de Francs

EXPOSITION INTERNATIONALE D'ÉLECTRICITÉ
PARIS 1881
GRAND DIPLOME D'HONNEUR

Adresse Télégraphique
EDISON, PARIS

PARIS, LE 23 rd October 1888
8, Rue Caumartin

Chs Batchelor Esq.
New York

Dear Sir,

I am in receipt of your favor in which you call my attention to a patent which you have taken out for a new Compound dynamo machine. You can be sure that it will always a great pleasure to me whenever I can be agreeable to you in any way, and you can always dispose readily of my services.

In the present case however it is necessary that you should first give me full particulars concerning your invention, in letting me know in which countries you have taken out patents, how many patents you have taken out, and under which conditions you would either sell the patents or grant licenses to manufacture your dynamo.

I must however call your attention at once to the fact that at present a dynamo, in order to meet the competition, must be able to be manufactured at a very low price. Even the present Edison dynamos are too expensive & have great difficulties to compete with the prices of the Gramme machines although Ivry has reduced its price to 600 Francs for dynamo of 25 lamps

900 Francs for dynamo of 50 lamps

1700 Francs for dynamo of 100 lamps.

You see now in what proportion prices have fallen since you left Europe & even on the prices which we quote above, our competitors find means to make yet a discount of 10 or 20 per cent.

What I want to show you clearly, is that at present a dynamo will only have a good sale if it is very cheap & it is quite impossible to pay high prices for dynamo patents or to increase much the cost price in paying heavy royalties.

Hoping soon to hear from you again,

Yours very truly,

A. Chatard

Form L. 1200-3-13-'80.

THOMAS A. EDISON,
No. 65 FIFTH AVENUE.

New York, Nov 12 1886

Batch = 66 / 32

It has just occurred to me that we have a better thing in our Converter than I first thought have your man figure it out — see if I am right —

1st The Armature of a 200 ampere machine running without strain from belt spa[illegible] can easily make twice as many revolutions per minute as when used as Dynamo.

2nd This being case with same strength field it can be wound to have 4 times lower resistance, hence at double speed give proper Volts & instead of 200 amperes Convert 400 amperes & Even then machine will work better than as Dynamo — & there will be no strain on moving parts due to this double load —

Let me know if I am Correct T A E

Batch -

Have made a machine for coating the plates it does it perfect can get thick or thin coats in perfectly even a good coating is only 1/4 of a thousand on each side — The machine makes 5 revolutions a minute — one hundred spindles with place to put plates on each side & one boy will do about 5 No 20 machines 6/1000 plates per day — I will design machine & Gilliland will come over with samples — I find that the burs on the large & 4 small holes are the cause of our troubles to a great extent am designing a machine to emery the burs off at one stroke — will also send that — I am making 50 plates to go under our press to test for crosses — I find those ~~[illegible]~~ telephone diaphragm plates used for tin types are rolled beautifully and you can get them 5/1000 easy where are they made — Here is a good point — The

magnetism of ~~bar~~ forged iron cores are increased 20 percent by annealing after forging — and 30 percent on cast iron some Italian has tried it — Cant you get the Bridgeport people well little Extra payment to anneal the cores well — also Taylor to anneal his field pieces; This would reduce the amount of iron required 20@25 per cent you might try the Experiment on 2 cores Exactly alike — as regards weight dia & ampere spires —

What about test on dynamo with Resistance in wires leading to Commutator

Yours

Edison

ers.

46 Difference of E.M.F. between outside and inside lay-
47 Brush gear for R.R.motor.
48 Proposed dynamo 110 Volts, 120 Amperes, 450 Rev.
49 New connection for commutator (Batchelor's)
50 Dynamo 125 Volts, 200 Amperes, 600 Rev. (proposed)
51 Insulation of armatures for high tension.
52 New winding (Edison's)
53 Method of measuring resistance of armatures.
54 Proposed dynamo 160 V., 200 A., 700 Rev. Square wire.
55 Saturation curve of [illegible] dynamo.
56 New winding (Edison's)
57 Proposed dynamo 160 V., 200 A., 700 Rev. Round wire.
58 R.R.Motor. Armature direct on axle.
59 Proposed dynamo 5 Amp. 110 Volts, 1600 Rev.
60 Saturation curve of [illegible] dynamo magnets.
61 Saturation curve of [illegible] dynamo magnets.
62 Plan for reducing speed of [illegible].
63 Plan for reducing speed of [illegible].
64 Sparking effect of [illegible] of coil.
65 Sparking on [illegible] machine.
66 [illegible] Combinations inside of [illegible] 100 Ampere machine.
67 Proposed magneto machine [illegible] 10 c.p. lamps (20 V.)
68 Effect of load on speed & efficiency of dyn. as motor
69 Arm. winding with displacement same as odd numbering
70 Conductivity. ing.
~~71 Vertical winding dynamo. Batchelor & Walter type.~~
71 RR Motor report on E M W Mich
72. Edison Motor for RR
73 New Winding for 400 Amp dyn
74 Iron showing between wires on an armature
75 Weston Motors
76. Displaced Winding
77 Vertical Winding on a #12
78. Directions for Municipal
79 Compound #4 for Marine
80 Sprague 3 HP
81 Sprague 5 HP
82. Heating Effect of current in armature
83

box or the tubing and let you know. Price.

April 22, 1886.

Telegram:--

Bad trouble send electrician & man at once answer promptly.

New Bedfrod?

Telegram:--

Electrician & man will come by Fall River boat to-night.

E.M.W.

April 23, 1886.

Trouble here is with pole line feeder running from catch-box on Purchase street to pole on Purchase and Union. Have made a cut but cannot do anything until a new length is received. Have telegraphed for it and an additional one; the number is 206. Purchase street main between Middle and William has been repaired. No other trouble.

Waddell.

April 24, 1886.

Two tubes from Brooklyn received and to-night will replace the defective one. No further trouble has occurred. To-morrow I will test the whole underground system together and then in sections and then the over-head system. This has been low in insulation since commencement and makes matters worse with the underground conductors. President of Company says these troubles are injuring the business.

Waddell.

64.

HARRY MINER'S PEOPLES THEATRE,

April 24, 1886.

#20 dynamo put in Sunday ran last night up to midnight, the load, 225 Amperes, was constant up to 11 P. M. when the load varied from 375 Amperes to 50. No sparking on commutator, the pillwo block on pulley side requires too much oil and heats up. With this exception the dynamo ran very well. The driving belt is saturated with oil and requires to be very tight is saturated with oil and requires to be very tight to prevent slipping.

Bourne.

Note:-- Heating of bearing is probably due to the tight belt.

MacDougall.

April 30, 1886.

The #20 dynamo, running two weeks, has started to "dig out" on two commutator bars. Filed commutator and sand papered dow down. Ran at night with bad spark; is not improving. This dynamo has from two to three hundred lamps thrown off or on, with warning.

14.

HOFFMAN HOUSE,

April 30, 1886.

Turned off commutator of #12 dynamo, it had two bars dug out This machine has been over-loaded. At 10.30 p.m. running well with full load on.

30.

GRAND CENTRAL DEPOT, April 30, 1886.

Running O.K. Commutator perfect. The lamps along platform are covered with dirt, which absorbed much of the light.

Bourne.

78.

NEW BEDFORD PLANT,

May 3, 1886.

I regret to report that at 1½ o'clock this noon our large "A" machine short circuited and made more fireworks than we have yet had in our station. Now we are putting our spare armature which we find to be a very handy thing to have in the house. Have not yet examined the burned one, but will report you later the amount of it.

Price.

72.

NEW BEDFORD UNDERGROUND SYSTEM,

May 11, 1886.

In relation to our last trouble we thought we would try to remedy it fearing that something might develope on that part of the line which now seems good, but our men have been very busy. I do not like to open boxes searching for faults which changes the position of things as your men left them, for any subsequent faults may be thought to be owing to our careless work on boxes which we may have opened We have not troubled any part of the line which now seem in fault. The following is report of my man on last trouble.

Price.

On last Friday night about 10 o'clock a dead ground on the negative side developed on our system. At midnight we started to hunt it out and found it to be on Feeder #1, upper William street. I disconnected the Union street pole and started up, when I found that the negative indicator did not light. Opened Union street box expecting to find the pressure safety catches fused but they were all right. When I connected up the pole so that current would be delivered to the Union street from Box #1, the indicator lit up showing that there was no current at the Box #2 from feed r #2 but it came from the other feeders. I also found a dead cross in Box #2 between neutral and positive of 10000 Ohms or less, how much less I could not say as I tested with a magneto, which rings through 10000 Ohms. This was in the centre piece of box itself, with all catches out. Have cut out feeder #1 and the system without it is all right with the exception of a very slight positive ground. Immediately we found there was a ground on the system, we started to locate it, so there was no chance for a ground on the opposite side to work out.

Palmer.

47

DEFECT REPORT FROM CHICAGO, May 15, 1886.

We notice the armature of one of the machines of the Union League Club gave evidence of the commutator having been turned down. If everything about the dynamo runs well we will say nothing about it but in the future should be glad to have you inform us in case you expect to furnish us a second hand armature for us to pay for a new one. Leonard.

TAGGING OF FIELD CONNECTIONS.

Tagging of field connections of dynamo #44 of class #12 was wrong. Our man connected it up according to the tags, and its field would not charge. He then connected it according to the standard method and it worked all right. Since then we have received two machines of class #16, #23 & 24 for the Union League Club here. In both cases the tagging was just the reverse of what it should be. As I did not know but that you had reversed your method of winding, I said nothing about it until I might have an opportunity to make sure of the result, but I now find that the standard method of connecting was correct and that the tagging was entirely wrong. None of our workmen out here need the tags to work by in connecting up a machine, but it sometimes may be convenient, in case of new men connecting a machine; but certainly no tag would preferable to tags that are misleading in every way. Leonard.

Notes to MacDougall:--

In regard to this complaint from Chicago in regard to worn commutator, will you in furture please call attention to the fact if there is any new machine going out that has a commutator on it which appears to be old or secondhanded.

In regard to field connections being tagged wrong you had better have some one tag these machines who knows exactly how they should be connected up otherwise we shall have some trouble where machines are sent to people who do not know as much about it as these Chicago people.

C. R.

72.

NEW BEDFORD UNDERGRUOND SYSTEM,

May 17, 1886.

The trouble with the system was reported to be a ground on #1 feeder and that a conductor in #2 was not feeding. The trouble as found by disconnecting was a leaky coupling box. When the compound was removed and terminals cleaned the insulation rose to 500000 Ohms. In looking for this fault, I found two boxes with water in them and two not completely filled with the compound. The trouble with #2 feeder I traced back to the station and located it in the equalizing box. When the resistance was taken out of the line, the connection was immediately made. Trouble was also said to be in #2 catch box there being a cross between the inner rings, but on

opening the box and testing, the insulation was found to be in the meg Ohms. There is still a ground on the whole system but it goes off during the noon hour, so is of some service. Would suggest a slight modification in the safety catch used in the catch boxes.

The objection is that the corners A projects too near the adjoining pole when being inserted in the box when current is on. The shape as shown in Figure 2 wo ld lose nothing electrically but would be less dangerous to use. It was suggested that the screw in the boxes for clamping the catches be made of brass for they rust badly now. They might be nickle plated

Waddell.

47.

DEFECT REPORT FROM CHICAGO,

WEAK FIELDS IN ROCKFORD DYNAMOS. May 18, 1886.

Have just received report from Rockford station, where they have placed two more #16 dynamos that have been running a few days. The new ones have not as strong fields apparently as the old ones, at least with identically the same speed, as they are all belted on countershafting and the pulleys are the same size. The old machines have eight blocks left in the hand box with 165 Amperes, and one of the new machines at 165 Amperes has the hand box short circuited, and the other one ha has but four blocks left with 180 Amperes.

Leonard.

79.

AMOS BROTHERS DYNAMO,

Syracuse, N.Y., May 20.

Hav examined and run the "Z" dynamo at Amos Brothers. The commutator was turned off the first of this month and there is much less trouble now than before, but the commutator is now decidedly out of truth. The brushes were in very poor condition and covered too large an arc on the commutator. I had the lod put on (46 - 10 c.p. lamps) and soon got it running with very little spark, and with a light load no spark. The trouble does not come on until after several hours run. Examined for grounds and base connections but found nothing. Tested the pressure and found it to range from 96 to 98 Volts. The lamps are 94 and 95 but but they say they are now satisfied with their life which is now over 1000 hours. The lamps

are somewhat low on account of being previously too high. The commutator will be turn d off this week and I will see how the armature runs on my return. When I left it, it was giving no trouble of any kind.

Waddell.

5.

LOCKPORT MUNICIPALS,

Lockport, May 21, 1886.

The following are results I have so far been able to get about the Municipal Dynamos :--

With one circuit of 35 lamps on the
Dynamo speed is 1434,
Engine " " 364
Extra resistance 430 Ohms.

With two circuits on the
Dynamo speed is 1448
Engine " " 363
Extra resistance is 320 Ohms.
Current on 2nd circuit is 2.8 Amperes.
Magnets heated to about 50 C.

The engine runs smoothly and light is steady. The armature is reported to run cool, which of course it should with only two circuits on. The lowness in candle power due to the current being less than 3 Amperes is complained of. This 2.7 Amperes was maintanied so as to save the dynamo.

Waddell.

14.

HOFFMAN HOUSE PLANT, #16 DYNAMO,

May 24, 1886.

Went to Hoffman House Saturday, found brushes sparking also a running spark around commutator, ran the watch out and got the spark reduced so that it was hardly noticable. Went there yesterday afternoon fixed up the brushes and commutator in good order. Left there at 10 P.M. with dynamo running in perfect order to the engineer's entire satisfaction. This plant is all right, all that is needed is a little more care from 6 to 8 P.M. while the load is being thrown on.

Browne.

80.

FALL RIVER PLANT,

Fall River, May 25, 1886

For two weeks past we have had trouble with one of our 400 Ampere, 125 Volt dynamos, (Four core pattern). It sparks intermittently during the evening, sometimes cutting one or more bars of commutator, say within two or five blocks of each other. We have suspected loose connections to the bars,

caused the sparking, but only on two occasions have the bars on diametrically oppesite points of commutator been affected. The irregularity of the sparking and the fact that it occurs at different points on the commutator never cutting the same bar twice is what puzzles us. Yesterday we took the head off expecting to find a loose connection but all were in good condition. The commutator is not grounded on the shaft so far as we have been able to determine. The only other theory we can form from its actions is that the insulation of the wires inside the armature is in poor condition. This we have no means of determining and as I understand it, if even a single strand of wires connected to one bar were to burn off their insulation entirely we would lose the armature. Can you suggest anything that would cause the disturbances we have described?

Dwelly, Jr.

5.

LOCKPORT MUNICIPAL,

May 23, 1886.

First reading to show relation of the resistance of each field magnet. The two magnets were placed across the mains of the regular system and drop in E.M.F. taken.

First with no extra resistance,

Left magnet gives 112.5 Volts drop,
Right " " 110.5 " ".

This shows that the left magnet has 50.4% of total resistance, the left having 49.6%

Second with no extra resistance,

Left magnet gives 112.5 Volts drop,
Right " " 111.6 " ".

Gives same as above.

Third, with 15 blocks resistance on right side,

Left 92 Volts,
Right, 121 "

This shows that total magnet resistance is 85% of the total and 15 blocks is 15% of the total resistance.

Assuming magnet resistance cold equals 675 Ohms and temperature has risen 12 C. then resistance is 700 Ohms. This would give the resistance of 15 blocks as 125 Ohms and one block, 8.3 Ohms.

Fourth, with 28 blocks in,

Left magnet has 80 Volts drop.

This shows that the 28 blocks equal 25% of total or 28 blocks have 233 Ohms, therefore one has 233 divided by 28 and 15 blocks have 232 (?) which checks #3.

Fifth, With 15 blocks in on right side,
Left 92 Volts drop,
Right, 120.5 " "
This checks readings #3 & 4.
Sixth, No extra resistance.
Left, 105.5
Right, 104.
From this we get left magnet has 50.4% total resistance and that right " " 49.% "
" which agrees with #1 & 2.
Seventh, 12 blocks in,
Right, 119 Volts drop,
From this magnet resistance is 209.5 minus 119 divided by 209.5 and multiplied by 2 which equals 86.6 %
Therefore 12 blocks have 107 Ohms,
From #3 & 4 12 " " 100 "
The above show that the magnets are all right.

Second readings to obtain the E.M.F. across the brushes.
First, when running in the regular way, viz, two circuits each with 2.75 Amperes, speed 1458 per minute, currenti in test circuit .6 Amperes, 18 blocks of resistance in or about 150 Ohms. Temperature of magnets about 65 C. 36 16 - c.p. lamps.

Drop from lamps 1, 2, 3, & 4, is		105.5 Volts
5 & 6,	"	102. "
7 & 8	"	95.5 "
9	"	89.5
10	"	88.0 "
11 & 12	"	96.0 "
13 & 14	"	90.5 "
15	"	82.0 "
16	"	80.5 "
17	"	81.5 "
18 & 19		81.0 "

Therefore total E.M.F. is		993 Volts

As a check, drop from 1 - 4 is 105.5 Volts.
With 5% drop in line this would give 26 Volts for each 16 c.p. lamp in street or at 3 Amperes drop would be 28 Volts which means 34 lamps available, instead of 38 lamps.
Second, All resistance out but two blocks,
Speed ,1450. Current in test circuit .7 Amperes. Temperature of magnets about 70 C. Current in street circuits nearly 3 Amperes. 36 - 16 C.P. lamps in observed circuit.

Drop from lamps 1 ----4	110.0 Volts,
5 - 6,	106.0 "
7 - 8	98.5 "
9	92.5 "
10 - 11	97.5 "
12	86.5 "
13 - 14	93.5

Drop from lamps,	15	85.0 Volts,
	16	83.0 "
	17	83.5
	18 - 19	84.0 "

Therefore total E.M.F. is		1020 "

With 5% drop in line this would give 27 Volts or at 3 Amperes full it would be 28 Volts.

Third, Conclusions:--

The present trouble with the system lies under three heads, viz:--

1st, Lamp resistance higher than originally calculated for.

2nd, Speed of armature too low by at least fifty revolutions, per minute,

3d, Magnetism of the field magnets is too near the saturation point.

The first conclusion is shown by deductions on pages 3 and 4.

The second conclusions and third go together, for the heat of the magnets is just double what it was calculated for.

As tested, current in field is 1000 divided by 1300 or .77 Amperes,

As run here " " " " 1000 " " 900 or 1.11 Amperes. Hence the heating varies as .77 squared to 1.11 squared or as 1 to 2.

To run at 3 Amperes per circuit would raise the heat three times as calculated for.

That the magnets are about saturated is shown by the fact that taking out all the resistance does not raise the EMF abo above 1025 Volts.

Fourth, Suggestions:--

If the present lamps and dynamo are to remain here, it would be well to change the present 34$\frac{3}{4}$" engine pulley to 38$\frac{1}{2}$". This would give an armature speed of 1550, which is not excessive seeing what trouble there has been with these #1 dynamos in regard to heating of magnets and E.M.F. The engine speed is now 360 and no trouble comes from it, but it night be well to bring it down a little and use a 38 inch engine pulley. The armature pulley in as small as advisable viz, 8$\frac{1}{2}$ inches, instead of 11$\frac{1}{2}$ inches as originally made.

It would be well to adapt a lower number of lamps per circuit, or to retain the present number here of 37.

Of a set of lamps recently sent here, an average Voltage taken from 27 lamps was 28 2-3 Volts.

Waddell.

Note:--

Do not think the municipal #1 magnets cab possibly be saturated, as the magnetic intencity on the iron core is only

about 75% of that on the standard machines. Nor can it be in the iron plates of the armature. The trouble is that on account of the extra insulation on the armature the field is now bored out more, making the distance from core to the pole-pieces 50% more than before. This requires more current thro' the field, and also a greater proportion of current through it to neutralize the armature effect. And each of these increments heat the fields in the square proportion.

Walter.

81.

DEFECTIVE "C" DYNAMO AT PEARL ST.

May 27, 1886.

One of the "C" dynamos at the Pearl Street Central Station made a cross with the base and this was found in the first copper disc on the commutator end nearest the iron armature. The insulation consists of one thick sheet of paper and two thin, this had given out.

Walter.

5.

LOCKPORT MUNICIPAL.

May 25, 1886.

Magnets keep hot and after are about 100 C. This is with two circuits and less than 1000 Volts. They are anxious to get another circuit on and will order large engine pulley if you give authority to run armature at higher speed.

Waddell.

May 26, 1886.

Company here have ordered large fly wheel for engine also larger armature pulley. They are anxious to get things straightened out and are doing all they can do towards it. The dynamo has been run as per catalogue, viz, at 1450 and engine has given no trouble. It should be insisted that the 16 c.p. lamps be twenty-five Volts when a three Ampere current is flowing. Even then only thirty eight lamps can be put in, using 1000 Volts E.M.F. Machine here was purchased on supposition that it would keep 40 - 16 c.p. lamps up to 16 candles, with reference to E.M.F. The machine now at 1000 Volts cannot maintain two circuits of 38 lamps each, with three Amperes per circuit. At 1500 speed it will likely have difficulty to maintain four circuits.

Waddell.

5.

LOCKPORT MUNICIPAL,

May 24, 1883.

From a number of readings the E.M.F. across the Municipal lamps here is,

Five new 16 c.p. average 27.6 Volts.
" used " " " small pattern 29.1 Volts.
Seven used 32 c.p. 28.3 Volts.

Current kept at 3 Amperes. No 32 c.p. lamps are now in circuit. Of the 16 c.p., 40 new ones would require 1100 Volts or 1150 line included. 40 Old, or lamps about 500 burned would require 1160 Volts, or 1210 Volts at the dynamo.

Waddell.

72.

NEW BEDFORD UNDERGROUND SYSTEM,

June 5, 1886.

Men very busy but will have line tested as soon as possible. This neutral ground was on when Johnson came and we still have it. While first may have gone off and another come on, the line has not been free since before he came.

June 8, 1886.

The lamps in the regulator box on positive side of feeder have intervals of going out and coming on again of their own account, they are out just now and we can only get test lamps to burn by connecting either wire with the positive of the other boxes; this seems to us to show that both are mutual some way.

78.

NEW BEDFORD PLNAT,

June 5, 1886.

Our engineer finds that the new pulley with the new armature is a trifle smaller than the old one, and the speed is a trifle higher. The heat seems more noticeable on the machine with the old armature still in it. Price.

Note to Price:--

You need have no fear of the #20 machines. The heating of that one machine may possible be due to the fact that you are running one faster than the other. Perhaps the belt was slack on the other one, thus doing all the load. We have tested the #20 machines in this place with 500 Amperes on and the heating is not perceptibly greater than at 400 Amperes. You must however keep them at the right speed especially if you have them in multiple arc, as if you do not and there is any slipping of the belt of that machine, the other one will not only take all the load but will drive that one which is slipping as a motor so that you would not notice that it was below speed.

Batchelor.

12.
BUCKINGHAM HOTEL,

June 9, 1886.

Dynamo running cool, commutator true, with smooth surface.
Bourne.

33.
CABLE ROAD,

June 9, 1886.

Turned commutator of #8 old style winding & connections This dynamo has run about five months without any trouble.

64.
PEOPLES THEATRE,

June 9, 1886.

Filed up commutator, did not have time to turn off. Dynamo running well considering condition of commutator. Comparatively small spark. On Monday this armature will be changed for a new one, perfect in all respects.
Bourne.

72.
NEW BEDFORD UNDERGROUND SYSTEM

June 11, 1886.

The trouble here was remedied early this morning before I got here and now on the whole system there is only a very slight negative ground. The trouble was a ground and cross on Purchase street Main. On the same there was a neutral ground in a small service which has been take off. The negative pressure wire of #4 feeder is intermittent in its connection and appears to be due to a loose contact It is not advisable to locate it. They complained last night of a series of sudden variations in a main which had been isolated during repairs. I do not think the trouble was due to anyt thing but a varying load. Waddell.

Note to Waddell:--

You had better not leave the slight negative ground until you find out what it is. By a 1 means find out what is cause o of intermittent trouble of the #4 feeder. Although say it is not advisable to locate the trouble I think that on their system there we should take up every little indication of trouble and follow it right on to the end to find out what it isor we shall have trouble on it all the time. Do not come away until you have found out what is the cause of the constant variations in the main which had been isolated.
Batchelor.

78. NEW BEDFORD PLANT,

June 11, 1886.

Two bars in commutator of new #20 dynamo are cutting.

Connections have been tightened and commutators are being turned down. Both commutators of small machines have high bars so they will be turned down too.

Waddell.

Note to Waddell:--

Endeavor to put their dynamos in shape so that they will be satisfactory to them. Get that nice glaze on the commutator that we get on the machines in testing here. Take a record of the variations of load of the different dynamos at all times so as to see just what they are doing there. If you have any trouble with these #8's let us know as we had better change them for new connections.

Batchelor.

69.

TROUBLE WITH #6 ARMATURES,

June 12, 1886.

Note to Lanston:--

Type 6 armature #55 after running for almost a full test finally made a dead cross, stopped the engine and threw the belt off. After looking the thing over we started up again and the cross was not in the armature then. After running a little it crossed again. This trouble is caused by the pounding of the wires when you are binding them up. I wish you would give orders that they must not pund it. The wire must be brought in position by the clamps. The slightest blow on the wire causes the insulation underneath it to break and make such temporary crosses as this likely to occur. We shall send this armature over to you and you will find that on the outside there are two wires that are slightly burnt. This is the only indication of the cross but when you take it apart you will find that the insulation of the wires or the ones underneath are cut so that it is possible to make a short circuit after the machine has been running for sometime.

Batchelor.

72.

NEW BEDFORD UNDERGROUND SYSTEM,

June 15, 1886.

Whole system now in satisfactory condition.

Waddell.

Arrived this morning and found our difficulties worked out to an extent that we have only a medium sort of dark old ground on the negative, and the positive shows nothing. Everything is connected, and with the above slight exception, everything seems right, for the time being. Mr.Johnson seems to convince me that what I thought was the neutral ground that

"he found and left" on the occasion of his la t visit was really two grounds and one was negative and that I was misinformed as to its being the same. As I saw it on the night he left it seemed too bright to have left, but he, believing it was in the wiring somewhere inside, thought we should run it down ourselves. I also believe that what I thought was a good test as I wrote you June 8th was too hastily concluded owing to our men being a good deal tired and overworked.

Mr. Johnson has found the difficulty too with the regulator box on our #4 feeder that I wrote lighted at times only. He opened the box and found one of the thumb screws quite above the lead wire so that the contact was very uncertain and occasional. On tightening the nut this morning the lamps came up and have remained so since. I would say what is right and proper to exhonorate Mr. Johnson from what seemed his, as I thought, apparent neglect.

Price.

78.

NEWBEDFORD PLANT,

June 12,

Have had new #20 commutator turned off and both of those of the smaller machine and all are run very satisfactory now.

Waddell.

Waddell has turned off all commutators and tonight I am going to try the #8 machine with a load and see how they work.

Price.

June 14, 1886.

Since turning off our #8's they are working nicely. A very heavy load was g iven them on Saturday night and they took care of it in good shape. The armature just arrived.

Price.

June 16, 1886.

Commutators have glaze you spoke about and seldom need attention except when the load is changed.

Waddell.

70

TROUBLE WITH #4 ARMATURES,

June 18, 1 86.

Note to Langton:--

Type 4 armature #65 has a resistance cold of .051 and hot .069. The average resistance of this type of armature is .044, so you see you have got a very much increased resistance on this which causes the armature to heat up above 100 Cent. with its ordinary load. It seems to me that you have on t his armature instead of #9 wire, possibly #10 or else the ire must vary in conductivity. Please be care ful and have these wires guaged before they go on he armature. We send the armature back.

Batchelor.

82.

NEW BRUNSWICK PLANT, June 21, 1886.

One of our dynamos shows spark or arc between bars of armature. We cannot find any trace of it when stopped. It appears only when the e.m.f. is raised above 106 or 108 Volts. What is the cause and how remedied.

Howell.

PILOT LAMP

The arrangement of pilot lamp underneath the yoke and between the cores of our dynamos is no good. In the new dynamos you will please put the pilot lamp on top,

Howell.

14.

HOFFMAN HOUSE PLANT,

June 23, 1886.

Put in new set of babbitt shells in pillow block on pulley end. Found old boxes melted and babbit seat badly burned. Started up before 4 p.m. and dynamo was running well at 9 p.m Belt on machine short and has to be run very tight.

Bourne.

1.

BUFFALO COURIER PLANT,

June 25, 1886.

Burned out babbitt boxes. We have advised them to cast solid ones.

Batchelor.

72.

NEW BEDFORD UNDERGROUND SYSTEM,

June 27, 1886.

Have still further trouble with underground system. On 26th worked difficulty down to piece of tubing in William street ... mani, cut it out and all customers were on. In afternoon while trying to take out bad piece a heavy thunder storm came up and chathes were blown in nearly all boxes. With dead ground on positive the #20 machine showed over hundred Amperes and the negative machine nothing. Machines finally righted themselves but chatches blown as far as put in. We had to run last light, Saturday, with some dozen of our customers out. Bought lamps for some. Others who had taken out gas fixtures had them and meters replaced at last moment. Been working all day, Sunday, but after cutting out some burned tubes and wet j ints on Purchase street where we had short circuit on June 9th, we find on connecting up, a dead ground between positive and neutral on that main showing trouble not yet eradicated. We see no way but to go completely over our system and replace present short boxes by longer ones and the other improvements that experience may suggest.

Price.

June 27, 1886.

Reported here 9 A.M. yesterday. Found neutral ground strong enough to redden two lamps in series. No new style boxes here and very few spare clamps. They cut out portion of main but few from the ends so as to give light to all consumers. Yesterday too wet to work. Towards evening dead cross occurred in main between and coppers. Burned out safety catches and threw out about 15% of system. Found cross this morning, took out bad piece of pipe. Cross caused to all appearances by leakage of water into box. One end of main all right and will feed some customers. In other end and wires are dead ground do cannot be used. Shall endeavor to straighten out in morning. Quite number of consumers cut out. Have isolated and tested one feeder (3) which is all right.

Clark.

Note to Price. June 29, 1886.

We are of your opinion that the sooner we commence operations at y ur station and put it in good running order the sooner will our troubles all around end. W suggest gradually changing all boxes for the new improved box of which we have some on hand and will ship them immediately and send man to stay there until they are changed. If the work can be got along quicker by any means after he has once started there please suggest the same to us and we will do whatever is necessary.

C.B.

83.

ARMATURE AT BRODHEAD, WIS.,

June 25, 1886.

The first night this armature started it caused a great deal of trouble by excessive heating and sparking. Pulley end of armature on starting up smoked excessively, dynamo instantly shut down. Started up again and operated rest of night without trouble. One night same thing was repeated, before dynamo shut down pulley end was throwing sparks at furious rate. Armature sent to us and new one sent in its place. Armature was evidently originally defective and would have sent it back to you only we thought we could repair it satisfactorily and make expense less to you. We found two adjacent loops so badly burned that there was no insulation whatever left upon the loops. Had commutator taken off and two loops replaced by new ones. Armature is as good as new.

Leonard.

4.

COMMUTATOR CONNECTIONS,

June 25, 1886.

We think vast improvement can be made upon present method of

connecting ends of loops to commutator. Had connections been made fater style which immediately preceeded the present style, the repairing could have been done without taking off commutator. Trifling repair on armature now seems to necessitate removal of commutator, and with heavy wire as now used on armatures it is difficult to get 176 screws in to hold commutator to loops. We found three screws in this armature which had been originally broken off at your works. There is a strong likelihood very often of there being no contact on the vertical surface between commutator radial bar and block into which end of the loop is sweat. Realizing trouble caused by melting of connections of old style, we think there is unnecessary complication about the present arrangement and something better could be readily devised. The "Y" and "S" machines cause more trouble from unsoldering of connections than any others. This trouble was entirely obviated there by us of pieces of heavy sheet brass cut in the shape of figure 1

Figure 1,

This piece of brass was placed on top of the connection, and the screw passed through the hole in the sheet brass and held firmly on top of the copper. The entire connector was filled with solder so that the copper wires and brass strip above were firml soldered together as show in figure 2,

Figure 2,

You can see from sketch, in case the connections be opened from any cause, the wires would not be able to spring up and open thatportion of circuit as brass strip would always be in contact with wires, which would keep the connection perfect or prevent it from being sufficiently bad to cause trouble. This treatment has yielded satisfactory results in some eight or twn instances and the simplicity recommends it in preference to present arrangement.

SCREWS & NUMBER OF CONNECTIONS,

Our armature workman said to writer as he was finishing armature above referred to, "Supposing I should twist off the head of one of these frail screws." Such a thing is often done as we find three instances of this kind on one armature as it came from Machine Works. It is tedious operation to bring all 88 connections of a #6 armature into such perfect position as to be able to put in 176 screws without injury to any of the screws. Our men derived the impression that you

designed the connection with special object of rendering it impossible for ordinar workmen to repair armatures without a number of special tools. We think a simpler connection could be made to give as good satisfaction.

Leonard.

83.

ARMATURE AT BRODHEAD, WIS.,

June 29,

Note to Chicago,

Brodhead armature must have had a knock between time tested here and time it was placed in the field. This is unavoidable to us and rarely happens.

C.B.

4

COMMUTATOR CONNECTIONS, June 29,

Note to Chicago,

Connection suggested by Mr.Leonard no good. Have used it but difficulty with kind of connection was not loosening of wires (that was easily remedied by making sides of cup higher and ending them over on the wire). The centrifugal force and heat acts on the screw to elongate it and make permanently bad connection between cup and tongue. Armature you s ask of was 88 block #8 which has been altered to 44 block by alteration of winding. No difficu ty with other sizes as none have so many commutator blocks. Shall be glad to make any tools you desire to facilitate repair work. Have no desire to keep anything back, have never shown desire to.

C.B.

72.

NEW BEDFORD UNDERGROUND SYSTEM ,

June 30, 1886.

Patched up system so that every customer has had light since 6.P.M. yesterday. Going to test out pole lines for neutral ground and if they are good shall try and neutralize trouble in underground system. In main which broke down we fo nd dead cross fusing the ends of the copper and 300 feet away a dead ground (positive) both occurring at junction boxes.

Clark.

THOMAS A. EDISON, PRESIDENT. CHAS. BATCHELOR, TREASURER AND GEN'L MANAGER. SAMUEL INSULL, SECRETARY.

EDISON MACHINE WORKS.
104 GOERCK STREET.

CABLE ADDRESS: "XYBUN NEW YORK." New York, ...

My dear Edison,

I find Siemens and also Hopkinson is putting in prices for dynamos to Italy — Now could we not sell there at price to isolates so less the amount that we have charged for royalty, there is plenty of money in it and we do not have to pay anything from these machines towards the $5000 paid back eh?

Batch

Yes would quote to Milan isolated price less royalty FOB there

E

CHARLES BATCHELOR COLLECTION

1887

Yonkers, Jan. 20, 1887.

Chas. Batchelor,

Dear Sir, —

Your telegram reached me in New York to-day about two o'clock, I was sorry to be obliged to answer in the negative, but the machine has a short circuit in the armature and as it has already been pulled to pieces two or three times I feel that it is necessary for me to be present when the repairs are made and I have engagements made for to-morrow and Saturday which I could not consistently cancel. It probably would be a short job to repair it in your works. Will try to see you in New York when you come in, and would like to hear from you as to your movements.

Yours &c Chas. S. Bradley

In replying please address
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THE EDISON MACHINE WORKS.

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SCHENECTADY, N. Y. February 10th. 1887.

TEST ON SPECIAL #1.

Ran for several hours on different loads and at end of this run was put on 50 amperes and about 110 volts for about a quarter of an hour, which it ran almost without spark. Temperature at end about 62° C.

Volts on magnets, no load -- 94, on dynamo -- 108,
Volts on magnets, full load--118, on dynamo -- 110.

Magnets were in multiple arc for this test, therefore volts on magnets were really 11½ at full load. Heat on magnet not too much, about the same as a #2 dynamo -- hottest of regular dynamos.

Armature resistance .278 (less than regular as armature is shorter).

Magnet resistance 50.2 (inmultiple arc -- 12.5 ohms).

The effect of the load is about the same on this machine as on the regular #1, as to the percentage of current required in the field magnets, but the charging effect is good, as it only takes three seconds to charge itself and be up to volts with full load on.

The commutator does not seem to cut out any bars at all, even though sparking a good deal (by pushing the brushes backward, &c.), probably the effect of the wrought iron. It appears to make a good motor.

The speed with magnets in series is 2,000, being five per cent higher at 110 volts.

Test on load for heat and saturation curve has yet to be made.

Should like to try an experiment with larger wrought iron pole pieces, as if we could reduce the air resistance that way it would be a good design for very small dynamos. This style at present takes a good deal of current to charge its field. As it charges so quickly it could be used for a headlight dynamo.

Magnet cores a little too short.

Total weight 472 lbs. as against 550 lbs. for the regular #1.

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(1)

SCHENECTADY, N. Y., Feb 14th 87

New style "1."

Armature 4.5" dia: and 4.25" at bevel. Length 6". Winding, 1 #15 (B.W.G. .072") 6 times round and 44 cont^ed blocks. Same winding as regular "1" same diameter of armature and same bore of field. Length of arm: 2" shorter than regular "1". Weight of wire about 9 lbs. Res: = .278 Ohms.

Magnet cores and pole-piece (being of the same piece of wrought iron) are 6" dia: at the poles and where the magnet winding is 2.75" thick by 6" wide = [illegible]. Section of iron being 14.5 □". Section of core of #1 = 19.5 □". Length effective for winding including fibre heads 5". Winding 50 lbs of #19 (B.W.G. .04[illegible]) Res: 50.2 ohms. (In multi-arc 12.5 ohms). The field has to be charged with 118 Volts to give 110 volts at brushes at full load at 1900, or with 2000 revs it can charge its own field in series at 110 Volts with no extra res:

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SCHENECTADY, N. Y., Feb 14th 87

For 1900 speed & full load the fields have to be in M.A. and 95% extra resistance inserted. They get rather warm at this.

Henry L. Walker.

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SCHENECTADY, N. Y., May 16th 87

My dear Mr Datchelor

Your letter received. The 8th, 9 & 10 tests on armature cores were on the following armatures. The #8th was on a 7½" armature with bronze discs and plates of the same metal. I coil was made about April 25th: there were regular plates on the armature (·012 & ·013") The #9 test was a second one on the 7½" thin disc armature, made May 4th 87, only for 5 hrs (marked 300 minutes on table), and the #10 test was a second one on the regular 7½" core, also for 5 hrs for a verification of the previous three hour tests with which they agreed very well. I think the table I send you includes all the data I have of the tests. It gives the temperature of the armature inside and outside, and

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SCHENECTADY, N. Y.,

that of the room, also the cooling value of the armature and the probable absolute heat generated calculated from this.

In regard to the extra resistance armature I enclose a copy of report of test. The winding is as follows. A regular "4" armature is wound in the usual way only the commutator is separated from the cups by a disc of fibre and the extra resistance coil is soldered between ~~them~~ each cup and the bar the cup should screw to. Each extra resistance loop is wound as double in order to avoid self induction. The resistance of each is .065 ohms so that three of them in multiple arc will be .022 ohms as the brush always covers three at once. As there are three on each side the total resistance of the armature from brush to brush = .022 + .046 + .022 = .09 ohms, where .022 is the resistance of three

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extra coils (in multiple arc) + .046 is the resistance of a regular 7" armature. The wire used is one length of 25 ft. of #16 wire which would be .058 ohms cold and would be .066 ohms — the right resistance — at about 60° C. White rubber tape is used to insulate, and the wires were wound on a wooden drum fitting the armature outside the wire and binding bands, with fibre sides, slotted. I am getting the drawing made out of the present armature, and also a sketch showing a possible method of a practical winding.

Yours faithfully
Henry S. Walker.

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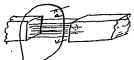
SCHENECTADY, N. Y., June 9th 87

Magnetic units.

Take 1 loop of wire cutting a certain number of lines of force once in a second and developing 1 Volt. Then call the number of lines of force that would produce this E.M.F. 10,000.

Then 1V = 1 length cutting 10,000 lines once in a second.

1 length being a.



In the case of a gramme ring each half of the loop cuts the same lines twice over in a revolution. The other half practically does not cut at all. In an Edison armature the same loop cuts the lines twice over and also there are two halves

Therefore for a gramme 1V = 1 loop × 100 = 5000 L.
an Edison 1V = 1 loop × 100 = 2000 L

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SCHENECTADY, N. Y., June 9th '87

Magnetic units (cont)

Therefore 1 loop on an armature going round once in a second developes 1V when cutting 2,500 l.

Let 10,000 lines be 1 (unit) intensity of 1 metre or 10,000 centimetres of iron section. Then by calculation from saturation curves 12,000 lines = saturation.

Since in a gramme ring connection with drum armature only ½ the coils develope the E.M.F. the other half being in multiple arc $V. = \frac{\text{No: of l.} \times 2\,T \times N}{10,000}$

Where V = volts
No l: = number of lines
T = turns (no) on armature
N = no: of revs per second

or $V = I \times \text{sec} \times 2T \times N.$

Where I = intensity (10,000 l per metre)
sec = section of core or cores in metres. A.E.W.

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SCHENECTADY, N. Y., June 18th 87

Chas Batchelor Esq.

I received your letter asking for results of charge and discharge of field with resulting induced E.M.F. in armature and would have replied before but could not make the 2nd test till yesterday as I have been busy figuring a new 110V 600 ampere machine for which figures were wanted in a hurry. I say second test because I have already sent Mr Edison the results of a test on a 7" dynamo about 5 days ago, giving also the charge &c after 1 sec. [illegible] & Mr Edison did not ask for the latter readings so I only took a couple of observations [illegible]

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SCHENECTADY, N. Y., June 18th 19

test. I think as a sequel to this test I ought to get the rise of current thro' the magnet coils themselves after closing the circuit, say 1 sec 2 sec & 3 secs after. From this I could get the energy absorbed by the magnet in charging, which it gives out in discharging.

I enclose some tests on "H's" & "G's". The results of core tests show that thin plates develope about $\frac{1}{2}$ the heat. But since on an "H" the heat on the core would be about $\frac{1}{3}$ of the total, we would only save $\frac{1}{6}$ part by using thin discs or say 20% of the heat. On a rise of 60°C this would mean 10° or 50° increase. On a "G" perhaps 30% may be saved. The question is whether there is sufficient advantage in that. Yours faithfully. Henry E. Wheeler

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SCHENECTADY, N. Y., June 18th 87

Test on charge and discharge of a "4" field observed by induced E.M.F. in armature

Volts on field with 0 extra resistance in its circuit – 127. 200° = 1 V.

0 extra res	c =	123	123	or .[illegible] V
	d =	256	256	= .675 V.
25% —	c =	118	118	= .[illegible] V.
	d =	246	242	= .[illegible] V.
50%	c =	111	114	= .[illegible]
	d =	232	228	= .[illegible]
75%	c =	108	107	= .[illegible]
	d =	212	215	= .56
100%	c =	102	107	= .[illegible]
	d =	196	197	= .[illegible]

Verification readings
- 75% again — 108 c = [illegible] d
- 50% — 114 c 245 d.
- 25% — 118 c 242 d.
- 0 — 122 252 d.

After 1 sec 0 extra res c = 80.78 = [illegible] V.
c = charge d = discharge d = 40.36. [illegible]

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SCHENECTADY, N. Y., June 18th 87

Tests on "H" & "Y" armatures.

H #6 Res: .0027 Ran 2 hrs 30 m on 300 A & last 30 m: on 375 A. Temp 88° C room 27° C.

H #77 Res .0084 Ran 3 hrs on 400 A. Temp: 86° C. room 25–30° C.

H #81 Res: .008 Ran 3 hrs on 300 A. Temp 76° C. room 23–26° C.

H #35 Res: .013 Ran 2 hrs 30 m on 300 A. & last 30 min: on 375 A. Temp. 90 room 25–29° C.

Y #14 Ran 2 hrs 30 min: on 300 A. last 30 min 375 A. Temp 120° C. Res. .0097 room 23–26° C. Volts 120. Field mags multi. etc.

Y #11 Res .0097 Ran 3 hrs 300 A. Temp 76° C. only room 23–26. But the volts were only 105. Field mags in series. Henry Watts

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SCHENECTADY, N. Y., June 18th 87

P.S.

The 16" armature with thin discs and brass sleeve (varnished discs) will be ready to test on Monday as a core test. It will then be wound for a regular armature

Did you receive the formulae for magnetism, section of core, and speed &c that I send you a few days ago?

Henry S. Walker.

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SCHENECTADY, N. Y., June 27th 87

Chas: Batchelor Esq.

The iron for the transformer is here now and we are ready to start on it at once. You were going to send us a drawing of the whole machine; if you cannot do that, Mr Kruesi wants to know whether you want a bronze sleeve next to the shaft, and iron plates. I believe that is what you told me you wanted. Or was it bronze end plate also? I figure for the dynamo winding 2 square rods .265" wide. For the motor winding we can take the figures you sent me tho' do you not think 26 blocks too few a number for 1200 volts. The only thing against using 52 blocks

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SCHENECTADY, N. Y., June 27th 87

on the motor end is that there would be a displacement of coils, as two coils would be close together and the next two (meaning one of the last and the next following) would be far apart. Thus:-

In else it could be wound with 104 divisions. Thus,

and with .062" fibre: this would make the square wire .088" less wide. If the squares were then made oblong that is .265" × .254" we will only loose 4% soil. This would be the best winding. The wire for motor end would be £ #11 4 times round using 1100 V instead of 1200. = + 52 cont^ble blocks for motor + 26 for Dyn: end.

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SCHENECTADY, N. Y., June 27th 87

I have not been able to make the other test on the "28" magnets for discharge & but expect to make it today or tomorrow.

Please let me know, when you are next writing, whether you have received the previous data on the above experiment, also the equations for magnetism.

Yours faithfully
Henry L. Walker.

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SCHENECTADY, N. Y., July 16th 87

Copy of

Working figures on Transformer for 1100 V 500 A + 1125 V + 58.5 A at 2000 revs. per min:

Armature sizes those of a "16", divisions 104 for .042" fibres.

Armature core to be made of .006" discs coated with the Edisons solution + bronze (and phosphor) plates + sleeves.

Winding, 2 rods .254" x .253" with .027" insulation once round and 26 commutator blocks (comm^tr regular "16" with every other bar brazed or soldered together). Weight of wire (rod) 94 lbs. Res: .0022 ohms. Winding = = vertical for 26 bars (to displaced).

Motor winding forming the top layer = 3 # 16's (~~[illegible]~~ .083") with .016" insulation, 5 times round and vertical

In replying please address
"The Edison Machine Works."

THOMAS A. EDISON, President.
CHAS. BATCHELOR, Vice-President and Gen'l Mgr.
SAMUEL INSULL, Secretary and Treasurer.
JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

(21)

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., July 16th 87

+ 52 commutator blocks (= displaced $\frac{1}{52}$) -

Weight of wire for this upper layer
= 115 lb. Resistance .234 Ohms.
(Regular 76' com- to but paper in bars)
for higher insu -lation

Insulation on armature :- .013 phosphor bronze wire
mica
oil
3 p.
3 tapes or silk
3 p.
2 tapes (p = paper .003" thin)

.03
.095
.080
.079
.076
.077
.003 or .026
.026
.076
.079
.026

Total .236

Outside diameter of armature
= 13.125" (13⅛) (to 13.00") Bore of field 13.375"

Magnets either regular 76's or Mun: 82 A.
every 2 in multiple arc & rest in series. If regular
76' magnets be used, 165 V. must be used
above, and then magnets be must be put

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THE EDISON MACHINE WORKS.

(3)

CABLE ADDRESS:
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SCHENECTADY, N. Y., July 15th 87

in multiple arc.

Binding:- 9 bands of phosphor bronze wire #13 (Bl.f. .095").

Heat, running freely, probably 50° C. (increase), & 60° more for current.

Henry Walker.

283
283

11.062
344
44248
11062
33186
3473468

11 1/16

.294

35000
4368
30,632
208
.983
.996
470

104 /

104
.042
208
416
4,368

.294

.30

1
2
3
4
5
6
7

[INCOMPLETE]

In replying please address
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THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Aug 18th 89

(2)

- mutator blocks for the same section of iron in the field-magnets; and again by doubling (or the increasing by 50%) the diameter of the armature and shortening the length in the same proportion the speed can be reduced to ½ (or the by 25%) which is another great advantage.

The watt capacity of this 20 & 2000 a machine is equal to that of a '76. If built on the same proportion the number of commutator blocks would be ~~[illegible]~~ $= \frac{20}{12.5} \times 58$ or about 8 blocks which is absurd.

The following are the figures on the machine.

Armature diameter 18.5" Length 15" Plates 5" deep Mag: intensity on plates 1.1 or nearly saturation. Inside space in

[INCOMPLETE]

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CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y.

(3)

Aug 18 '87

armature 8.5". Speed 500. Winding - 14 #5 wire (B&S. .0522") twisted as will be shown below = 680 c.m. per A.

Magnets 18" wide x 6" deep (possibly 6½)
Length effective for winding 15".

The tendency to spark will be from 25 to 50% more than a 76" I think, but a 76" is a very good machine.

With such a large diameter of armature an Edison magnet would weigh ~~so~~ much as the keeper & pole-pieces would be so long. We send you a drawing of general sizes of course only roughly sketched out. Also send a sample of twisted wire to avoid foucault currents by each wire having the same E.M.F. In order to prevent heating

[INCOMPLETE]

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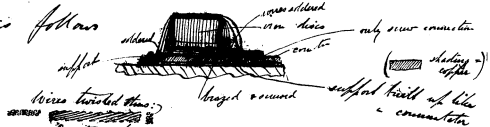
THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

(41)

SCHENECTADY, N. Y., Aug: 18th 87

inside I propose to run copper rods thick of 1000 c.m. per amp that is about 8½" × ½": and in order to overcome contact resistance the 14 #5's are soldered right into holes in this bar. It will be seen in sketch. The contacts are shown as follows



There is a good deal of work in this machine but the winding is simple, and the speed low and in spite of this the total weight less than a "16".

Armature resistance (wire alone) .0003 with coppers about .0004. Wt: of #5 wire 166 lbs. Wt: of wire on magnets about 400 lbs.

Yours very faithfully Henry E. Walker.

8000 Dr.

1000
20
40000

16

8 Block.

12" x 20"

18 x 15

x 5 x 12
180

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THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Sept. 6th 87

Chas. Batchelor Esq.

Dear Sir

I enclose you full report of 48 Amp. Municipal test.

In regard to the oiled paper you left me to test, I find that while two of them will stand a 1/4" spark and the other will only pierce in one place at that E.M.F. they would not stand a 3/8" spark at all. They seem tough but if hurt sharply will pierce at the head more easily than elsewhere. The triple oiled paper a sample of which I tested for comparison will not pierce at all at 3/8 and has hurt sharply, but in the latter case it goes thro' easily.

Yours very faithfully
Henry A. Walker.

[ENCLOSURE]

In replying please address
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SCHENECTADY, N. Y., Sept 6th 87

48 A [illegible] (1)

22 Hour test on 48 Ampere Municipal Dynamo

A copy of first part of test is enclosed with these few remarks upon the latter part of test which was chiefly for testing the insulation of the machine under sudden current variations.

During the 24 hour run the machine ran without any spark that could not be got rid of by adjusting the brushes a little. Also on the 2 hrs with 25% extra load, a 60 Ampere, the brushes were only adjusted once after they were first set.

At the end of the two hours run a extra load, 16 A was put on the bank of lamps and the circuit was broken suddenly by chopping wire with a hatchet. There was

[ENCLOSURE]

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SCHENECTADY, N. Y. Sept 6th 81

48 A test (2)

hardly any sparking, comparatively speaking. Then the whole load was thrown off in the same way. The brushes sparked a good deal this time, but no damage was done and the commutator was hardly scratched, only two brushes were fixed at the point slightly. This experiment was repeated with about the same results. As most of the load (32 A) was on the motor the spark on breaking the circuit was not very great, in fact the breaking of the 16 A lamp load received more of a spark than the 28 A. broken when the motor was on. The reason probably being that as the 16 A load was thrown on to the 32 machine it only fell that a potential of 100 volts or so for the motor

[ENCLOSURE]

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SCHENECTADY, N. Y., Sept 6th 87

48 A test (3)

would then take the load) whereas it fell that 1200 V. before; that is, outside of the effect of the discharge of the armature.

Then the full field (on 1200 V + 16 A) was broken without doing any damage at all as far as testing goes to show. The spark was quite small on breaking probably due to the copper spools.

The movement of the brushes was then taken for different loads and during this run the 48" was loaded to 60 A. and the 32" (motor) up to 40 A. The 48" sparked a little probably because of the forced breaks (it was not tried to get the spark out beyond moving the rocker arm), and the 32" did not spark at all. The base of the 48" at the

[ENCLOSURE]

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SCHENECTADY, N. Y., Sept 6th 87

24 A ~~[illegible]~~ (4)

and if all runs was 900,000 hours.

The curve or rather points in non-spacing point curve are as follows:—

full size — 0 12 24 36 48 60 a. going up — on a 4¼" radius
0 12 24 36 48 60 a. running down

The above is not absolutely correct as the speeds were not taken. In fact at the 24 A load there was much more load on the engine than on the 36, (as 24 A was on lamp tank & 36 a meter) therefore the 24 reading should be higher as speed was probably low, and so field stronger.

Harry S. Wallace

P.S. The resistance of [illegible] had indicated a temperature of the wire of 100° C. It is possible the wire may change [illegible] at [illegible]

[ENCLOSURE]

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SCHENECTADY, N. Y.

48 A test (5)

Aug. 31st – Sept. 1st /87
24 hour Test.

48 amp. mun. Dynamo #1 Armature #1
Extra resist. without load = 653 ohms (measured from box)
Speed = 715
Extra resist. with 48 amperes = 199 ohms (measured by drop)
Speed = 700
mag. resist. = 1318 ohms at 15·5°C
" base (cold) = megohm
" resist. (hot) = 1514 ohms
" base (hot) = 5 megohms
Arm. resist. = ·584 ohms at 15·5°C
" base (cold) = megohm
" resist. (hot) = ·829 ohm
" base (hot) = 200 000 ohms

After an interval of 2 hours,
Run again for 2 hours with 1225 volts and 60 amperes
(temp. of the armature given on another sheet)

K. Iwactare

H.E.W.

[ENCLOSURE]

In replying please address
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CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y.,

45 ℓ Lost 16

August 31st – Sept. 1st /87

Time	Speed D.	Temp. D.	Temp. M.	Temp. air	Drop.	Time	Speed D.	Temp. D.	Temp. M.	Temp. air	Drop
9:15 AM	700			18	157 – 1207	10:15	696	51	53.5	20.5	
10:15	702					11:15	695	50.5	53	19.5	
11:15	710					12:15 AM	697	50.5	53.5	18.5	
12:15 PM	711					1:15	697	50.5	53	18	
1:15	716					2:15	690	50	52.5	17.5	
2:15	700					3:15	695	50	52	17	96 – 1207
3:15	719	45			120 – 1200	4:15	701	50	51	17	
4:15	715	49	50			5:15	703	50	51	17	
5:15	719	49.5	51			6:15	703	49.5	51.5	17	
6:15	695	51	54	24		7:15	688	48.5	51	18.5	
7:15	692	51.5	54	23		8:15	695	49	52	18	
8:15	695	51.5	54.5	22		9:15	696	50	53	20	
9:15	693	51.5	54.5	21.5	117 – 1195						

Temp. of 48 amp. armature after 24 hours run as dynamo observed every 5 minutes.

No. 1 Therm. 62 – 77 – 95 – 102 – 104.5 – 105.5 – 106 – 107 – 106.5
No. 2 Therm. 64 – 81 – 98 – 103 – 104.5 – 105 – 105 – 105.5 – 105

Temp. of 32 amp. armature after 24 hours run as motor observed every 5 minutes.

No. 1 Therm. 85 – 88.5 – 94 – 95 – 93 – 92 – 91.5 – 90

Temp. of 48 amp. armature after 2 hours run with 122.5 volts 60 amperes.

No. 1 Therm. 102.5 – 105 – 108 – 109.5 – 109

K. Sundane

A.E.W.

In replying please address
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JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Nov. 8th 87

My dear Mr Batchelor

I have just figured out a transformer system for Paine & Francis which you refered to us a few days ago. I gave Mr Insull the figures and he sent them in to you. I afterwards thought that you might like to know the winding of the transformer that I proposed. It really figures out very well indeed, I mean the whole proposed plant. The transformer would be a "16". Regular magnet & armature cores. Magnet winding same as Num 32 A. Armature winding 2-199's once round & 34 blocks & 1 #14 B.W.G. 9 times round = interspersed winding. Speed 1200. I was afraid to

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CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Nov. 8-87

give an estimate on a higher speed until we can get the transformer now in construction tested. I think this will be a fortnight yet.

I received your letter about the two different styles of dynamos for 130V 54 A & 1200 rms. I expect to get the figures out by Thursday or Friday.

Yours very faithfully
Henry E. Walker.

P.S. The method of starting the transformer from the other end of the line, that I refered to, is the one on which we have made application for patent. Do you happen to know whether they are going ahead with that patent?

H.E.W.

30 x 6 x 2 7/16
loose sets
23 x 3 x 2 7/16 split
18 x 10 x 2 7/16 split
light 9.9
Rack
Felt
1 1/2 Reel Mot.
1 1/2
Pressed
16 1/2 x 11

CHARLES BATCHELOR COLLECTION

1888

EDISON ELECTRIC LIGHT CO.
J. H. McCLEMENT,
COMPTROLLER.

16 & 18 BROAD STREET,

New York, Jan. 7, 18 8 188

Chas. Batchelor, Esq.

214 East 18th. St. N.Y.

Dear Sir:-

Replying to your favor of the5th. inst, in reference to an offer you have received for 100 shares of Bergmann Co.'s stock at $90 per share, which you are obliged to offer us at the same price, I beg to say that the Executive Committee at its meeting to-day decided not to exercise its right to purchase this stock, and, therefore you are at liberty to accept the offer.

Yours very truly,

J. H. McClement

Comptroller.

In replying please address
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THOMAS A. EDISON, President.
CHAS. BATCHELOR, Vice-President and Gen'l Mgr.
SAMUEL INSULL, Secretary and Treasurer.
JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

(1)

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y. Jan 24th 88

Test on Transformer 16

Motor 700 V 50 A. + 60 V Generator + 450 A.

Speed 1250± Efficiency 77%.

700 V 52 A + 63 V + 500 A.

Speed 1300 to 1225 (74 per second) Efficiency 81%.

At 1300 armature began to vibrate a good deal, so did not run volts higher. Have tried ballancing the armature with end flywheels but that does not work so well as ballancing on the head.

The brushes on the dynamo or generator end had to be moved up about three bars or about 1¼" to get the spark out, the three on the motor end had only to be moved a trifle, say ⅛".

The direction of the lines of force to the armature may be imagined thus:— I suppose that as the dynamo coils are farther from the

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THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

(2)

SCHENECTADY, N. Y., Jan 24th '88

Transformer 76.

pole pieces they distort the effect of the motor coils which are nearer so as to give them no backward lead & then take a forward lead themselves.

The difference in the proportion of the volts of one coil to that of the other is accounted for by the fact that the dynamo coils loose a number of lines of force by their lead, but to a certain extent this is made up by an increase of current in the coils as the pole being moved further forward has not such a repelling effect & therefore takes more current & balance it (the set of dynamo coils) against the motor coils.

The armature diameter is 11.0625". It is made up of .006" iron discs coated with the Edisons solution, & had bronze (not phosphor) plates & aleans. Divisions 52 for .042" fibres. Winding 6 .144" wires (with .012" insulation) one round. Resistance .1822 ohms.

In replying please address
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JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

(3)

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Jan 24th 88

Transformer "16"

And above this, 2 #12's (B.W.G. .109") (.016" insulation) 16 times round. Res: .198 Ohms. 22 com'tr blocks in each winding.

Field magnets regular "32 Amp" cores in a series of two, in multiple arc with each other. Res: 390 Ohms. These got considerably warm in 1/2 an hour. Bore of field 13 3/8". One end of pole piece was set out afterwards about 3/64".

Henry S. Walker.

In replying please address
"The Edison Machine Works."

THOMAS A. EDISON, President.
CHAS. BATCHELOR, Vice-President and Gen'l Mgr.
SAMUEL INSULL, Secretary and Treasurer.
JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y., Jan 28th 88

My dear Mr Batchelor

I write you a few lines to tell you of the success of the new experimental a c machine, which if you remember I proposed some time ago and have tested satisfactorily a few days ago. It is like this Iron rotor magnet on each end. It works very well, better as a motor than as a dynamo. Had it running from 0 load to 25 or 30 A without a sign of a spark. Load thrown on & off. As a dynamo it was not quite compounded enough for non-sparking altho' it was overcompounded as far as voltage go. I have applied for a patent & rather have forwarded it to Eger & Seley. We are going to make a larger one, as you can hardly tell its real practical value unless it be tried

In replying please address
"The Edison Machine Works."

THOMAS A. EDISON, President.
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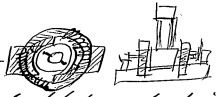
SAMUEL INSULL, Secretary and Treasurer.
JOHN KRUESI, Assistant Gen'l Mgr.

THE EDISON MACHINE WORKS.

CABLE ADDRESS:
"XYDSUN NEW YORK."

SCHENECTADY, N. Y. Jan 28 '88

on a large machine.

It can be made thus:- 

When I get a good set of tests on it I will forward them to you. In the meantime I think it will be a very practical thing on a large scale, if I can only get a patent on it. It comes near if you remember the patent referring to this, I forget the name of the man. But it only comes near it in principle & not in any way in construction. If there be no other in the way, I fancy we ought to get a good claim. Of course it will belong to the Machine Works. I do not know exactly what arrangement it is to be made yet.

I remain yours very truly
Alex McWalter

TELEGRAMS AND CABLES:
"PHONOGRAPH, LONDON."

TELEPHONE:
No. 1962.

EDISON'S PHONOGRAPH CO.

181 Queen Victoria Street, E.C.
LONDON.

Feb. 20th, 1888.

Chas. Bachelor, Esq.,
Edison's Laboratory,
Orange, N. J.,
U. S. A.

Dear Bach.:

As requested in your favour of the 3d inst., I have communicated with de Liman, and will give him an opportunity of doing something in the Phonograph if he should so desire.

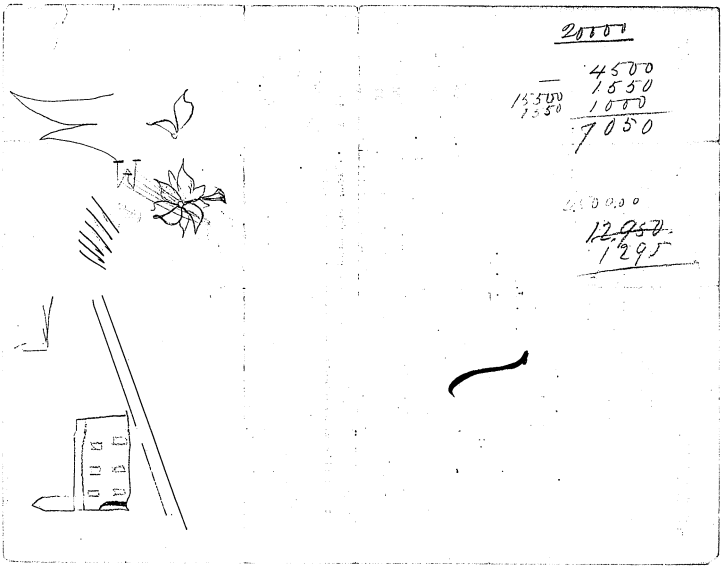
How glad I shall be when, in order to get the interesting and useful information you can from time to time give me, you will only have to talk--not be troubled to write--a possibility in the very near future according to a late telegram from Orange. I wish at the earliest opportunity you would give me a little talk about the progress of things generally at the new laboratory. From all present appearances the Phonograph business is going to be a great business if only you good fellows do the right thing in making it.

With kind regards to yourself and Mrs. Bachelor,

Believe me,

Very truly yours,

G. Gouraud


20000
4500
1550
1000
7050
15500
1550
12950
1295

MEMORANDUM.

TO My Dr Batchelor

FROM THE

EDISON ELECTRIC LIGHT CO.,

16 & 18 BROAD ST.

New York, Mch 9th 1888

A 2000 note comes due on monday I shall sell Sprague or Bergmann to meet it - As I will have to sacrifice I may as well do it for your benefit - Will you take either stock at 65 $ - Both are cheap at that Telephone me so I will have time to otherwise arrange it Yours Mr E. H. Johnson

12.500

6000
2000
2500
2080

Batch Stock

EDISON ELECTRIC LIGHT CO.

16 & 18 BROAD STREET,

New York, March 17th 1888.

Charles Batchelor, Esq.

Edison's Laboratory, Esq

Orange, N. J.

Dear Sir:-

Replying to your favor of the 10th inst. I beg to state that our Board has declined your offer of 250 shares of the stock of The Edison Machine Works at par.

Yours very truly,

J. H. Hastings

Secty & Treas.

Copy of portion of agreement made this 12th day of May, 1888, between Thomas A. Edison of Llewellyn Park, in the State of New Jersey, party of the first part, and the Edison Phonograph Works, a corporation organized and existing under the laws of the State of New Jersey, party of the second part.——

"Fourth. And the party of the first part agrees for himself, his heirs, executors, administrators and assigns, that of the stock issued and delivered to him or them pursuant to the provisions of this contract he or they will, immediately upon its receipt, transfer and assign thirty-eight per cent, (38%) of the stock so issued and delivered to him or them to a trustee to be agreed upon between him and the party of the second part upon the following trusts and conditions:———

1. That said stock so delivered to the trustee shall not participate in any of the earnings of the party of the second part, nor be entitled to share in any dividends. If, however, the earnings of the Company which it decides to declare as dividends in any one year amount to over twenty-five per cent (25%) on its entire stock exclusive of such stock so held in trust as aforesaid, then such trust stock shall be entitled to participate ratably with the other stock in such excess; and——

2. That the party of the first part, his heirs,"

Extract from minutes.
Edgar W. Dinsmore
Secretary.
May 13, 1905.

MYRON O. BROWN,
PROPRIETOR.

THE SAGAMORE,
GREEN ISLAND, LAKE GEORGE.

Bolton Landing, N.Y. June 21st 1888.

Mr Chas. Batchelor:

My dear Sir:

Will you kindly call upon my sons Mr James A. or Mr Edwin D. Trowbridge at No 16. Nassau Street - to confer with them about your proposed plans in regard to No 33 West 25th Street - They will act for me, and I prefer to leave the matter entirely with them.

Yours very truly

Mrs A. H. Trowbridge
per J. A. T.

57. E. 34th

259 W 74th

259 West 74th St
New York

Jam
Same
[illegible] City

57 East 34th St
New York
City

Vermilye & Co

New York January 1888.

Chas. Batchelor Esq.

Dear Sir,

Regarding consent desired by you from Mrs. A. H. Trowbridge to put bay windows on No. 33 West 22d St, I have consulted with my brother & we decided that it would be no injury to adjoining property. Therefore you may go ahead so far as owners of No. 35 are concerned.

Yours truly

Clement A. Trowbridge

2

language, and it would perhaps be well if you would place one of the German gentlemen in your employ at his disposal as an interpreter.

Yours, very truly,
H Villard

Dictated

Villard

Mills Building.

New York, Aug. 13, 1888.

Charles Batchelor Esq.
Orange, N.J.

Dear Sir:

I beg to introduce to you herewith Mr. William Venator, one of the chemists in the employ of Messrs. Siemens & Halske, who came to this country under engagement to me. In the absence of Mr. Edison I would ask you to let Mr. Venator be shown over the laboratory, and to allow him to avail himself of the facilities of it for an experiment, the nature of which he will explain.

Mr. Venator is not as yet very fluent in the use of the English

[FROM FRANK McGOWAN]

Cali Columbia
August 26th 1888

Charles Batchelor Esq
Orange, N.J.

Dear Mr. Batchelor:-

I duly received your very welcome letter of June 2nd & desire to thank you very much for your considerate thoughtfulness in thus keeping me in your memory. I am very glad to hear that you deemed my letters worthy of such polite attention as to have their contents read to your family, & had I for an instant thought that you would have been interested in my journey, I would most assuredly have asked Mr. Tate to pass them along to you. I knew of course that you disliked travelling, but Mr. Batchelor, there is a vast difference between travelling in the U.S. or Europe & travelling in Mexico. I do not know how my letter appeared to you, Esq & by myself & then I think that you will have the same opinion. Still I have recently learned that it is well for humanity at large that the Anglo-Saxon race is at the ascendant & that race civilization follows in their (wake) wake.

I would have answered your letter sooner had I not had an attack of malarial fever. Four weeks ago the time had come when I had to suffer for my negligence & the little rules that had carried me so far & so safely & that called real of their 40 miles a day for a fortnight at a stretch were to be reached with fevers. I felt that some kind of siege would soon overtake me as I had run myself completely down & as I made up my mind to take my gruel like a man as I did with the fever, but what was my disgust to getting rid of that to find that I had to suffer a most malignant attack of Bilis & here I have been for nearly 3 weeks confined to bed & unable to walk a block my length at any time. Now I never had that trouble in all my life. What gives it to me! Horseriding. Curses on the horseriding, say I. It has caused me more suffering than the whole of my journey put together. I will try to explain how it came about.

When I came to Cali I was about 27 lbs in weight, though I felt in pretty good condition. I had to buy a horse & a good one at that because the roads here were in a fearful condition & I did not intend to go mooching around on a poor animal & yet known when I least afforded it. I paid $185 for a horse & $50 in silver for a saddle. I bought the horse from the representative of Ewer Bros. & man by the name of Symmonds who recommended the animal to me as one of the best in Colombia. Symmonds is a Germany Jew & was known as the best means. The horse is a thoroughbred which is saying much for a little horse for locomotion of horses. Well I want no more horses when I get through with this trip. For the first 2 months I suffered all kinds of tortures in sweet silence. People used to wonder why horseriding played me out so. & I used to attribute it to my inexperience & bad handling of the horse. Yet the animal had a habit of tripping himself up & falling on his knees thus rendering my little to 2 pitched headlong over a cliff at any moment. When I stated your defects to any one I knew they tell me plainly that I was no horseman & that the fault lay with me. I agreed with them & heartily wished that the occasion was past which called for an effort on my part to sit on the equestrian art.

Dear Sir & Friend

Mary, the white rose, just faded

Yes Sir I would be one your young friends

And that I must look out & [illegible] season the stuff by fire, Prof. when I called about May 3rd that I had come thus far I wanted what was I not surprised what to do in order to prevent my act! Here I have gone over a vast expanse of country alone doing everything I could find in this valley & had I known what to do I could have cut my travelling short considerably. Then again I asked if I was to [illegible] the Cultral Conditions? No Answer Came [illegible] of these questions my was I told whether the agents [illegible] & I left from Quito had been received.

I am told that I can very profitably employ 2 years down here in planting the Magdalena River & the Valley of Magdalena & Mahson. This form of such an experience would just about suit me off.

I have not received the mail of Colombia I asked for & would feel obliged to you Mr. Batchelor if you would forward me mail. Can find mail there in Quito. If you forward it a [illegible] to know distances from place to place.

You will also read in my last to Mr. Edison how our expedition discovered 16 mines. One of them, the Edison Mine, I think is particularly good. As 7 of the 16 belong to Mr. E. I have called one after his little daughter Marion, two bears the name of Mr. Johnson's children, Edna & Eliza & two I have called after your two children, Rosanna & Emma. His makes 6 mines already named & as I dont know the name of Mr. E's latest. I will keep one in reserve until he & you know what I have named. & as Mrs. E. cannot be applied to enter the lists in such short notice, I awaken on Mrs. Johnson & Mrs. Batchelor to receive said mine from Security by the advent of a [illegible] girl. No boys stand a show & will not be considered. I have asked Mr. E. & Johnson & Tate to send me some money on my approval, etc. to pay for all assessment of these mines to Lott here. Mr. E. to give me the money back when I return. Should he consider to develop the mines. Esq Mr. Johnson & yourself will have a finger in the pie & I ask Mr. Batchelor that they will not be allowed to slip through my fingers through not having $1500 to secure them here. Could you have gone with me through the Edison Mine you would have been greatly surprised with me. It goes without saying that what I say is sincere. I am willing to lose all I staked in these I staking I am not in the say but at all events I do not like to be deceived by Tate. My only difficulty now is in my [illegible] to get all mining stuff to Lott. [illegible] & I cannot then so that the young bear here [illegible] & after long Could Quito to the Cali. [illegible] just what measurement had to be made.

I am now about to have a hard time in trying to get over this country. The rainy season is on us again. The roads will be impassable. [illegible] overflow into huge rivers & the whole Valley inundated.

Trusting to be again favored with one of your very welcome letters when you have a spare [illegible] & kindly remember me to your family & also to all the boys. I am, Mr. Batchelor

Respectfully Yours

[illegible]

One day I had a 30 mile stretch to make & I picked up a Gentleman on the road who wanted me to have his mule & he would ride. It was late at night when we arrived at his home and just before doing so he fell on his knees & it seems only by a mighty effort that I held my seat & thus saved myself from a hard fall. The next day this man asked to ride. After riding for a few minutes he turned to me & said "Mr. Denver this is the hardest riding horse in Colorado." Now you know why I had to make such long trips on such an animal!" Well I had made to get that horse back to Colo. Mistaking distance & any speed I had thought of an office job I had to leave this ship & two months horse. So I sent him off on a big ranch to get fattened up. He soon took it over & at night I chain my animal that was tied to a post but I had to keep him in food. I have just got him back from the ranch & he is as good as when I left him there. Meanwhile I bought another horse & after making 3 trips with them he kicked the bucket and the buzzards fell away with him. On a coaching job I delighted down hill.

You may take for power two from 30 miles going & of course the time lost although I sometimes feed and water. Monday arrived in general directions for what I write & generally say a little the outlook in the city. During a journey I find I have my tongue to drink. Be different Rules water home good time. I have to ride with a blanket that serves with a carpet & all of clothes on because I have no idea what kind of weather I may strike. At night time I have to keep with all my clothes on the ground dampness of the earth. Bamboo lands & the country through which I have 3 different kinds. I feel sure as small as what chief on to your neck & wants killing. Mosquitoes full of blood & like leeches & making painful areas which you scratch until the blood comes & the pain is excite to be then bad. Many a night have I slept outside a corner door by exhaustion of this terrible annoyance. I slept outside much of the time for means certain death. Then the food. I must state that Colorado to try & write without anger when I think of the bad food and their unparalleled laziness. From Ecuador to Lima I have not seen a plough worked in a field. Have not heard the sprightly air of a motive, nor listened to the clank of a blacksmith's hammer. In this Canca Valley indians seem to be regarded as a curse by the inhabitants. As long as plantains grow wild near to their abode they will not trouble themselves about cultivating any other food product. Perhaps you or you must partake of Colombia's national dish, Sancocho, composed of small pieces of plantain boiled in water with sometimes 2 or 3 pieces of yucca chopped up and that constitutes all the food Quito Ecuador & the Indian Peoples. You have no idea how degrading it is for a gentleman to have to live on such a night. Of course I literally starve on such living. No matter how I manage I must be hungry. I generally suffer the consequence is that I can hardly sleep. My opium also of order at any time but I can take the bread out of Canning along with me some cans of preserved salmon. Oh but I remember some days & some prisoners I one day asked one of the dudes here who he was looking around waiting for the ship to fill & catch train. Instead of this man coal & going out on the country with a shovel & pick on his back a decent job on the country. Just think of Peruvian Con. no Peruvian (Lafora) Marriage Laws. Two Europeans here and has so disgusting that recently all classes in Colombia. I asked him if a friend of yours if he would not come with me on my expedition up the mountains. He gasped as if the would have to do. I told him he would have to walk all other mountains from early dawn to dark, evening rest & he had to take a chance with a lizard or bear. He said that Commanya had to do every thing in order to make a living but that Commanyas were for robs of a favored race. Well it is impossible to hear these people discussed as they are from a band of Cowards, cutthroats, who violated every law of humanity in their unnatural conquest of the Incas. Talk on this subject. This will do. In my last letter to Mr. Adams I made out an Expense Account of the Incas Pieces of Stuff which I calculated would leave Commanyas about 20 Lots. Out of those 4000 Pieces I could only send 100 & just not very good Stuff & I put all the blame on the Peons, but I have since found that I was wrong. I now come to the conclusion that after a certain time from the description by the bamboo of the Incas pentained I when found I running day not rely in Wilder. So I have to ship in the small Pieces chiefly on goods from I thought that possibly the principal ground might be of Tramp, as I selected a strip of ground above over the Valley & into the mountains to find I found the better material. Gathers has interfered Comment that if I had taken two days I was perhaps as well that I did not ship the whole wood. It would have cost me from this out alone.

Cutting stuff with our machetes, Labor	
Together for Sufficient Carrying stuff to Cana River	$296.00
Our rights for floating stuff down to Cana Landing	300.00
Four thousand mules for carrying stuff to Cordova	1200.00

Now there is the freight from Pucamaurca to Pucamaurca, thence to Cordova. Nobody understand is something frightful & from Cana to Mt. Ecuador. The fact is I have only commenced my journey. I think by Oct. what I would ask do of the Pucamaurca Mallet which is very large. Where the Spaniards when they first came from Peru have stamped the Incas 12 inches in diameter & sent them to Spain as great curiosities. But the expense of shipment would be something awful to contemplate. I would have to take them to mules beyond the Central Cordillera & the Magdelena River & I doubt if I could get 10 miles a day time thus. Of course I could get the stuff in that Rivers I would be all right because I would build large rafts and float everything down to Barranquilla. Living I found in the rich valley. When on the other hand, when on my way from Cordova to Lima I observed good stuff in the mountains I was going to stop & get in debt.

P.S.

On late date July 2. states that Mr. A

Inserts
Sawai

Can Mrs Traegers no 302 Garden St
Hoboken N. J.
Oct 8th 1888.

Mr C. Batchelor

My dear Sir.

I am sorry I trouble you too much, but if you will be kind enough to give me full information concerning the followings & tell me how to get I will be ever so much obliged to you.

I have a friend of mine well known in our society at home who asked me about the improved phonograph of Mr Edison & how to get one by the last mail. His intention is nothing of commercial character, but he is a rich gentleman, who want to have every scientific curiousities before every body have it & want very earnestly to get one, before it becomes common. His idea is to show the wonderful accomplishments of Mr Edison to his friends & to intelectual & good society of people with popular scientific lecture of the invention by Mr Edison.

If you are so kind to make some

arrangement to let me send one before you send them many by agent I will be very much obliged to you.

As I said before there is nothing commercially dangerous & I can swear to that with our Consul generals name if you like; & if you have any objection from patents or anything of that sort we can get our patent for Mr Edison if you choose. The rich Gentleman to whom I refer is a good friend of our president of our university & many eminent governmental officers; & I have no doubt it will make wide known the wonderfull invention of Mr Edison to our best class if not even to our Emperor.

Of course in case of purchase possible, we pay all expenses right away & send through your agent or from me directly according to convenience. Anyway he wants in the very quickest moment before it becomes common.

If you want to enquire more about the condition personally I will be very willing to call you in Orange or in N.Y. if you notify me.

Hoping your favour & Awaiting your answer I am yours very truly K. Sawai

JOHN C. TOMLINSON,
COUNSELLOR AT LAW.

(Dictated)

46 Wall Street,
New York, Nov. 27th 1888

Charles Batchelor Esq.

Orange,

N. J.

Dear Sir:

I have your letter of November 26th. As requested I have delivered to Mr. English, abstract of title of the house 33 West 25th Street, deed from Walter K. Collins to Rosanna Batchelor, tax receipts, guarantee of the Title Guarantee & Trust Company to Rosanna Batchelor, contract between from Walter K. Collins ~~between Walter K. Collins~~ and Charles Batchelor, application to Title, Guarantee & Trust Company, copy of will of George C. Collins, receipt of Title Guarantee & Trust Company for $260, and type-written memoranda in regard to title.

Yours truly,

J. Lucke Tomlinson

CHARLES BATCHELOR COLLECTION

1889

Cable Address "Edison, New York."

From the Laboratory of

Thomas A. Edison.

Subject: _____

Orange, N.J. Jan. 9th 1889

Chas. Batchelor Esq
Edison Phonograph Works
Orange N.J.

Dear Sir

I enclose my check No 1128 for $2622.37/100 the same being your proportion of the moneys paid in to date on account of the Sale of the Capital Stock of the Edison Phonograph Company.

Further payments will be made you to complete full amount standing to your credit in this connection as soon as remittances are received by me.

Please sign the attached receipt and return as soon as possible and oblige

Yours truly
Thomas A. Edison
R

P.S.

Also enclose please find check for Telephone Royalty amounting to $100.00/100

T.A.E
R

$\frac{500000}{50000}$ | 6250

80 / 500000

400

200

400

400

0

6250

43750

$\frac{160000}{22222}$

2 / 1000000 | 80

$\frac{160000}{22222}$

$\frac{56250}{39375}$

$\frac{500000}{450000}$

$\frac{50000}{40000}$

$\frac{10000}{8000}$

$\frac{2000}{1600}$

$\frac{400}{320}$

80

2622.37

374.62

$\frac{500000}{50000}$

$\frac{450000}{40000}$

$\frac{40000}{32000}$

$\frac{8000}{6400}$

1600

1280

320

256

64

$\frac{500000}{400000}$

Cali, Colombia
Jany 22nd '89.

Charles Batchelor, Esq
Orange, N. J.

My Dear Mr. Batchelor:-

As a last resource, and to me my only available one, I write to ask if you will kindly let me know why I have not received any letters from headquarters during the past 6 months? I have now been in the Cauca Valley 9 months and during all that time have received but one letter from Tate dated July 2nd. containing about 5 lines with relation to business. The last 2 lines read thus

"Mr. Edison does not want you to return for the present. I will write you when he wants to regulate your movements."

I have written Mr. E in vain & have even cabled him that I awaited orders but all to no purpose. I sent good samples of stuff by steamer leaving Buenaventura on Nov. 18th but dont know whether they ever got there or not. I am keeping an expensive horse here which costs me $1 a day for food alone & I rarely use him as I cannot take him into the mountains with me & yet if I got an order for a big shipment I must have a horse to bring me here & there to look after packing, securing mules, &c. &c. I have allowed the mines to go by default after spending over $500 of my own money. There was no use of my going any

further into the matter when no one would even take the trouble to write me a few lines to say that it was all right & that the mines would be looked afterwards. Thus am I served after all the pains I have taken to go every place I was sent & a great many more besides. The few ducats I had saved up for a rainy day I throw away on a phantom thinking that I was benefiting my employer by securing them (the mines) for him for all time to come. Had any one told me in N.Y. that I would have been served in this way I would have laughed the man to scorn. Here I am with my body full of malarial fever in vain trying to get some one to tell me whether I am to make any more shipments &c. &c. People hereabouts look upon me as a fraud & wont believe that I am in any one's employ. I dont blame them. I look upon myself as a dead beat & when my present remittance is all gone I'll go on the bum & be in reality what I am now only in appearance. I'm disgusted but never discouraged. Fate now even Fate never wove the web ~~that~~ of adversity that would discourage me. But I'll be at some one's funeral by & by for all this neglect. To get a man stuck down in this lower bound country & then leave him in the lurch. Oh, there will be a war dance by & by & some one will have to run the gauntlet.

I am now about to start over the Western Cordillera & go to the Pacific coast. How long I'll be gone I dont know because I intend to follow the old Spanish road as far as possible. I expect that this exploration will be a big thing. I hope I dont get knocked out by the fever. I am going right in amongst the

Indians. After this expedition I intend going over the Central Cordillera.

Now Mr. Batchelor wont you kindly drop me a line & let me know what all this silence means? A man by the name of Tom Davis who was a mining supt. down here may call by & by on Mr. E. He is a great talker but the less attention paid to him the better. He wants to see the gold ore separator.

With kind regards to your family & hoping they are all having an enjoyable time, I am,

Respectfully yours

F. McGowan.

EDISON ELECTRIC LIGHT CO.

REMOVED TO 65 BROAD STREET,
44 Wall St.
New York, May 16/89. 188

My Dr Batchelor

Will you please send me an
a/c of the payments you have
made on the Sprague Patents
in France together with any
suggestions you have to make
as to how you think you
should be dealt with in
respect thereof. Do you prefer
to have your money back simply
(with interest) or do you prefer
to retain an interest in the
latter. How & to what extent do
you think our agreement
should be modified? I am
willing to do whatever you
wish without reference to
my own opinion or view of
the matter. Yours truly T. A. Edison

35
200

350
750
200 / 11.00 (0.0
66.00 (0.35
00

CHAS. BATCHELOR,
33 WEST 25TH STREET,
NEW YORK

June 2 1889

My Dear Edison —

Yours of 16th May to hand — The money I have spent on Sprague patents in France independent of the two drafts you have sent to Brandon is about $2200 — Will give you a detailed statement of this as soon as I get a little settled — I have only just moved and all my effects have been in the Storage Company for the last 12 months — shall be able to get at the papers in a few days. As regard to the question of your letter, I must remind you that I have never asked that the money I have spent on Sprague pat. be refunded to me — As to my choice of having the money refunded to me with interest or a rearrangement of the understanding between us I should decidedly prefer the former if agreeable

Very truly Yours

Chas Batchelor

MEMORANDUM.

To My Dr Batchelor

Referring to yours of _____ 188

FROM THE

EDW'D H. JOHNSON, Pres't & Gen'l Mgr.

SPRAGUE ELECTRIC RAILWAY & MOTOR COMPANY,

16 & 18 BROAD STREET,

NEW YORK, June 3 1889

Our right - make up your a/c - and I will refund you the money with interest. Yours Truly

E H. Johnson

THOMAS A. EDISON, PRESIDENT.
CHAS. BATCHELOR, VICE-PRESIT.

SAMUEL INSULL, TREAS. & GENL. MANAGER.

J. HUTCHINSON, SECRETARY.
JOHN KRUESI, ASST. GENL. MANGR.

THE EDISON MACHINE WORKS,

GENERAL OFFICE AND WORKS:
SCHENECTADY, N. Y.

No. 19 DEY STREET,

CABLE ADDRESS:
"XYDIUM, NEW YORK."

PERSONAL.

NEW YORK, June 26, 1889.

My Dear Batch.:

I believe you and Mrs.Batchelor have between you five (5) shares of Lamp Company stock. On this stock you owe to Mr.Edison for transmission to Mr.Villard the difference between $10,250.00 and $12,000.00. That is to say, $1,750.00 per share, or a total of $3,750.00. This is payable one-third in cash, one-fourth in Deferred Stock and the balance in Preferred Stock. In fact, the same proportion of stock and shares and cash as we received from the General Edison Company. I make the figures to be, cash $2,917.98, Preferred Shares 56 and Deferred Shares 21. You will find on checking my figures that the fractiond of shares of Preferred and Deferred Shares have been added on to the cash as being the most convenient way of getting rid of those fractions. Will you please let me have this cash,stock and certificates before you go away, as I have to make a settlement with Mr.Villard's Private Secretary, Mr.Spofford, forthwith

Yours truly,

Samuel Insull

To Chas.Batchelor, Esq.,

8750
29166
2187.50
3645 84

8750
51.04 16
Cash 3645 84

Sel 29166 66
1250
29 04 16
54 16
2850.

[FROM CHARLES BATCHELOR?]

August 27, 89.

My Dear Edison,-

WASTE WAX.

I have had Aylesworth make an experiment in regard to recovering the stearic acid from the old wax, and he finds that he can recover very easily about ninety-two per cent of the stearic acid and cerasine. His process is decomposition of the wax by the acid, and purifying and separating the parts by distillation in vacuum. He says that steam distillation would answer, but considering the danger, trouble and care, and also the expense of having to boil a considerable quantity of water off afterwards, distillation by vacuum is preferable. The vacuum is about 28 inches; and is got by an ordinary water pump. I am, therefore, making him a kettle about 36 inches diameter, with a copper top suitable both for getting the vacuum and also for running the distilate over into suitable chambers cheaply. Immediately this is done, I think we shall be able to give them a price for the old wax.

ORE MILLS.- The Mallory single magnet has been done now for a few days, and is already painted up to go away. The other one will be finished in a couple of days, when they will both

be shipped together

We have just made an extended test of the single magnet. We found that it would be necessary to crush a little smooth before putting it on the machine, and here, therefore, substituted brass bars 3/4 of an inch high on the outside of the drum instead of wooden ones, which were on when you were here. I noticed that the ore was just going into the brass cylinder, so that it would soon have worn it away. We have remedied this by shellacing strips of canvass on, which after our extended test of twelve hours run, with ore continually running on it, did not show the slightest sign of being cut up. The heat inside the cylinder reached 205, but I do not consider this as anything, as it cannot be exceeded, this being the hottest season of the year. It has been a very slow job with the other magnet, as I have had to reorganize the bottom shop, discharge a lot of the men, and get others who will attend to the business in better shape.

I send you cutting about Wilson. This is a sorry ending for such brilliant talent.

Yours very truly,

Thomas A. Edison, Esq.,
Paris, France.

Edison Phonograph Works.
October 1st 1889

Dr. Condensed Balance Cr.

	29	868	08	Cash					
		651	69	Petty Cash					
	44	000	09	General Expense					
	15	561	52	Wax Cylinder a/c					
	3	103	44	Appliances					
	105	573	98	Machinery & Tools					
	33	488	99	Furniture & Fixtures					
	67	403	60	Real Estate & Buildings					
	5	989	79	Small Tools					
	53	028	50	Phonograph Tools					
	11	093	73	Installation of Fixtures					
	40	501	13	Material					
	187	247	44	Order No 1					
	13	435	03	Old Phonograph a/c (Scrap)					
	7	550	70	Packing a/c					
	9	458	18	Accounts Receivable					
	156	000	00	Manufacturing Rights					
		23	96	Toy Phonograph Tools					
		478	23	Toy Phonograph					
	24	816	91	North Am Phonograph Co.					
				Capital	300	000	00		
				Accounts Payable	23	460	93		
				Bills "	241	667	70		
				T.A. Edison personal	25	236	16		
				" " Loan a/c	5	100	00		
				Mortgage a/c	10	000	00		
				Sales a/c	203	810	20		
	809	274	99		809	274	99		

Duplicate

Cable Address "Edison, New York."

From the Laboratory
of
Thomas A. Edison.

Subject, _____ Orange, N.J. 3rd Oct. 89
14.50 o'clock

Mr. Batchelor

Dear Sir

On removing the head and drum from the magnets we found the leakage to be general and no single short circuit. There was no water inside but it was soon evident that the coils had been quite wet — soaked through — and partly dried during the delay in fixing the commutator & spark break. We put full current on the coils last night to dry them out, and Atwood has used covers to all round the magnets to keep the heat in. They seem by this time to be not quite but nearly dry. He is having a little trouble with pushing on those coils we took off. As soon as they are back in position, we think japan will be the best thing to apply as a first coat, and then at the last to pour in asphalt after everything test O.K. There seems to be no reason to suppose any sparking occurred between magnets and the coils. It would be a very troublesome job to remove all the coils and put copper sheets in between.

I ordered the two #12 machines by telephone with Schenectady this morning as you desired, and the written order will be posted this evening.

I have received the drawings of the Orange Track. I think that as you will probably desire them to be kept for Mr. Edison's examination together with the figures

Cable Address "Edison, New York."

From the Laboratory of Thomas A. Edison.

Subject. _____ Orange, N.J. _____

on them, that it would be well to have rough tracings made of them just the gradients and outlines say as Thomas thinks the owners will not care to have them here very long and that Mr Effel has been very courteous to him personally in the matter. If you should not desire to come tomorrow I would recommend your asking Thomas to do this, as his men are busy just now and he doesn't like to take a man off without your wishes I think. I haven't yet had time to take the figures up, but will take the first opportunity. We are now just going to take diagrams of the factory engine.

I have seen Gladstone this morning and showed him the results of the late (battery) tests. We think that while he cannot avoid going on with the manufacture of 200 hour zincs and coppers, that he might arrange to make copper plates for 100 hours with rolled zincs to match so that if people prefer it they can have a battery that lasts 100 hours and then require fresh zincs copper and solution.

Hutchinson is worrying us duly about the meter plates which are in fair way now except that Gladstone cant keep the mould hot enough with those little plates not having gas, but he is going to buy a cast iron charcoal stove.

There is a good article on Electric Traction by Louis Bell which we have to get at our fingers ends, in this week's Electrical World.

Yours faithfully
A. E. Kennelly.

W. P. A.
REN ALLEN DOTY, President.
JAMES PACKARD, Vice-President.
OYAL C. PEABODY, Sec. & Treas.
C. J. FIELD, General Manager.

EDISON ELECTRIC ILLUMINATING CO.,
OF BROOKLYN.
358, 360 & 362 PEARL STREET.

Telephone, "540 BROOKLYN."

BROOKLYN, Nov. 26th. 1889.

Mr. Chas. Batchelor,
33 West 25th. Street, New York.

Dear Mr. Batchelor;-

I have decided, instead of taking any salaried position, to go into the construction business for myself, and have about organized the "Field Engineering Company" for electric railway, light and power construction and consultation business, totake the superintendency of installation of plants and also contracts outright.

We are going to start out on a moderate scale with $30,000. capital to be increased later as the business warrants. We propose to give especial attention to electric railway work, both for power and electrical plant. I believe this work in the nex t three or four years is going to present one of the widest filods possible. I also am trying to work up a general consultation business. I already have the position of Consulting Engineer to the Brooklyn Company, as well as several other things of this class in view.

What I want is to obtain your influence and assistence in holding work from Mr. Edison the same as though I were going with him directly. It will be directly in my line and I believe I will be in a position to be of more use to him than if I worked with him directly, as the part of his work that I desire, as Silver Lake, Niagara, or anything else like this, would be directly in my line, and I would be glad to put as much time as he desired at his disposal.

When the Silver Lake plant is gone ahead with, I would like to obtain the construction work there either on percentage basis or contract outright.

I may see Mr. Edison before you have a chance to speak to him on the

FORM 7 A.
ETHAN ALLEN DOTY, President.
EDWIN PACKARD, Vice-President.
ROYAL O. PEABODY, Sec. & Treas.
C. J. FIELD, General Manager.

EDISON ELECTRIC ILLUMINATING CO.,
OF BROOKLYN.
358, 360 & 362 PEARL STREET.

Telephone, "540 BROOKLYN."

BROOKLYN,

(C. B. -- 2).

matter, but if you have a opportunity any time, I would like you to put in a good word for me.

I would like, also, if possible, to obtain your connection with this enterprize to a small extent, as one of the stock holders. We are not in need of money, but I want to get two or three parties whose good will and influence I consider it would be advisable for the enterprize to have interested in to a nominal extent.

We propose regularly organizing and incorporating the Company. The majority of the stock will be owned by a young Engineer friend of mine and myself. He is investing most of the money, as I have not any amount of my own to invest.

I believe that such a business will not only pay me a much better return than any salaried position but will be a good permanent business.

I am going into this after careful consideration, and although I have several very good offers in the way of salaried positions, including Mr. Edison's, I feel that this is the opportune time for starting such a Company, and with good hard work and determination, such an enterprize cannot but succeed. If others, with no influence or experience whatever, or very little experience at least, can go into this business and make money, I do not see why I should not.

May I have the pleasure of hearing from you on this matter at an early date, as I propose to put the matter through at once.?

Yours very truly,

C. J. Field

CHARLES BATCHELOR COLLECTION

EDISON PHONOGRAPH WORKS

The following documents, dated April 8, 1890 through February 11, 1903, and numbered 1 through 9, were found, together with a contents list, in one envelope.

Contents. 445

1 Contract between T A E & C B. Apl 8 1890
2 Letter of Tate (T.A.E. Sec'y) enclosing contract executed Apl 12 1890
3. Letter Randolph to C B. enclosing check first dividend
4 Letter (~~copy~~) C B to T A E. Nov 13 1899 asking for dividends
5 Letter T A E to C B He does not understand
6 Letter T A E to C B Stock rec'd no div until 20% paid
7. Statement by C B of what took place between C B & Gilmore
8 Copy of Statement made by C B to Lewis Feb 3 1903 –
9. Letter of Lewis to C B. Better get T A E to consent to see other Contracts

#1

Thomas A. Edison
with
Charles Batchelor

Agreement

Dated, April 8th 1890

Eaton & Lewis
Attorneys and Counsellors
120 Broadway (Equitable Building) New York City

A G R E E M E N T, made this 8th day of April, 1890, by and between THOMAS A. EDISON, of Llewellyn Park, State of New Jersey, of the first part, and CHARLES BATCHELOR, of the City, County and State of New York, of the second part.

W H E R E A S, the said first party is the owner and holder of 1,185 6-10 shares of the capital stock of the Edison Phonograph Works, a corporation created and existing under and by virtue of the laws of the State of New Jersey; and

W H E R E A S, under and pursuant to the terms and provisions of a certain agreement made and entered into by and between the said first party and the aforesaid Edison Phonograph Works, bearing date May 12th, 1888, and more particularly of the Fourth section thereof, the said first party has transferred and assigned the said 1,185 6-10 shares of such stock to The Mercantile Trust Company, of the City of New York, upon certain trusts and conditions set forth in two certain other agreements made and entered into by and between the said first party and the said The Mercantile Trust Company, and bearing date respectively the 21st day of January, 1890, and the 8th day of April, 1890, reference to which said agreements is hereby made for greater particularity; and

W H E R E A S, the said first party proposes to retain intact his title to the said 1,185 6-10 shares of

stock, but desires and intends that the said second party hereto shall receive the dividends, benefits and profits arising from 118 56-100 shares of such stock held by him as aforesaid, although he, the said first party, does not intend hereby to transfer or set over the said stock or any part thereof, to the said second party, or in any way to divest himself, the said first party, of the title to said stock or any part thereof:

N O W, T H E R E F O R E, in consideration of the sum of One dollar by the said second party to the said first party in hand paid, the receipt whereof is hereby acknowledged, and of other good and valuable consideration, it is agreed as follows, to wit:

F I R S T. The said first party hereby covenants and agrees that he will promptly assign, transfer, convey and pay over unto the said second party, all and every the dividends, benefits, profits and rights of every kind and nature whatsoever hereafter accruing to him, the said first party, upon the said 118 56-100 shares of the said stock of the said Edison Phonograph Works, to whatever extent this may be possible without divesting himself, the said first party, of the title to the said shares, it being distinctly understood and agreed that nothing herein contained shall operate or be deemed to operate to interfere with the uninterrupted holding by the said first party of the said 1186 6-10 shares of said stock.

S E C O N D. It is hereby further understood and agreed that this agreement shall be binding and accrue to the benefit of the executors, administrators and legal representatives of the respective parties hereto, and shall continue and shall remain in force as long as the said first party, his executors, administrators, assigns or legal representatives, continue to hold uninterruptedly the said 1185 6-10 shares of stock so deposited in trust as aforesaid, unless sooner terminated in accordance with the provisions hereof.

T H I R D. It is hereby further mutually understood and agreed that in the event of the death of the said second party, the said first party or his legal representatives, shall at any time thereafter have the option and right to demand that an appraisal be made of the value of the then interest of the said second party, in the said stock, by an appraiser to be agreed upon by the said first party or his legal representatives, and the legal representatives of the said second party, or if the said first party or his legal representatives and the legal representatives of the said second party are unable to agree upon such appraiser, by a board of three appraisers, one to be named by the said first party, or his legal representatives, one to be named by the legal representatives of the said second party, and the third to be named by the two so chosen, the determination of a majority of said appraisers to be final and binding; and the said first party, or his

legal representatives, shall have the further option of acquiring the said interest of the second party and of thereby cancelling and terminating this agreement by paying over to the legal representatives of the said second party the value of such interest so determined as aforesaid, and the said legal representatives of the said second party, shall upon the receipt of the amount for which the same has been appraised, thereupon convey, assign, set over and retransfer to the said first party, or his legal representatives, by conveyance, good and sufficient in law, all rights hereby granted to the said second party.

F O U R T H. It is agreed that nothing herein contained shall prevent the first party, or his legal representatives, as the case may be, (a) from at any and all times voting on all of the said 1,185 6-10 shares of stock herein referred to, in such manner as he or they may deem best and (b) from selling or otherwise disposing of all of the said 1,185 6-10 shares of stock herein referred to, at any time in such manner as he or they may consider best for his or their own interest and that of the second party as herein provided for. It is, however, further agreed that if at any time hereafter the first party or his legal representatives shall sell, transfer, assign or in any way dispose of the said 1,185 6-10 shares of stock of the Edison Phonograph Works, or any part thereof, or his rights therein, he or they will immediately thereafter either assign, transfer and pay over to the said second party or his legal

representatives, all and every the benefits, profits and advantages accruing to him, the said first party, or his legal representatives, from the sale, transfer or disposition of the said 118 56-100 shares of said stock in which the said second party is interested, as herein set forth, or will transfer and set over, or cause to be transferred and set over unto the said second party, or his legal representatives, 118 56-100 shares of the said stock, subject to the limitations and conditions imposed by the said trusts created by the aforesaid agreements made and entered into between the said first party with the said The Mercantile Trust Company, at the option of the first party or his legal representatives; and it is further understood and agreed that if at any time hereafter the said 1185 6-10 shares of the stock of the Edison Phonograph Works now deposited with The Mercantile Trust Company, in trust as aforesaid, should be released from the trusts created by the aforesaid agreements of January 21st, 1890, and April 8th, 1890, subject to which they are now held, the said first party will thereupon and at once assign and transfer unto the said second party 118 56-100 shares of such stock, and that in the event of the liquidation of the said Edison Phonograph Works for any cause, during the continuance of this agreement, and while the said stock is so held in trust, the said first party or his legal representatives, will immediately assign, transfer and pay over unto the said second party, that portion of the assets of the said Edison Phonograph Works or the avails thereof, received by

the said first party, or his legal representatives, and fairly and properly apportionable to the said 118 56-100 shares of the said stock in which the said second party, or his legal representatives, may be entitled an interest hereunder.

IN WITNESS WHEREOF, the parties hereto have hereunto subscribed their names and affixed their seals, at the City of New York, on the day and year first above written, this agreement being for convenience simultaneously executed in two like parts.

Thos A Edison

Witness to Mr. Edison:

L. B. Eaton

Chas Batchelor

Witness to Mr. Batchelor:

L. B. Eaton

#4

Nov 13 1899 Letter Chas B to T.A.E. –

asking for dividends on Ed. Throns Wks
Stock that was in Trust in Mercantile
Trust Co + he answered by letter #5

Cable Address "Edison, New York."

From the Laboratory of Thomas A. Edison.

PHONOGRAPH DICTATION.

Orange, N.J. Nov. 16, 1899.

Chas. Batchelor, Esq.,

Edison Building,

44 Broad St., New York.

Dear Sir:

Your favor of the 13th inst. came duly to hand and in reply I beg to state that I do not understand your request.

To obtain control, a certain part of the Edison Phonograph Works stock was put in trust for me in the Mercantile Trust Company and this stock only gets a dividend after the regular stock pays twenty percent.

Yours truly,

Thomas A. Edison

Letter CB to LAS. Nov 17 1899

our contract says nothing of
stock in Mt Trust Co being deferred
so I did not know it — Does this
stock only receive dividends after 20%
per annum has been paid to the
other stock CB

In answer to which I got letter
6.

Cable Address "Edison, New York."

From the Laboratory
of
Thomas A. Edison.

Subject,

Orange, N.J., Nov. 23, 1899.

Chas. Batchelor, Esq.,

44 Broad Street,

New York.

Dear Sir:

In reply to your favor of the 17th inst., I beg to state that the Edison Phonograph Works stock which is held in trust by the Mercantile Trust Company of New York, does not draw a dividend until after the other stock has paid a dividend of twenty per cent.

Yours very truly,

Thos. A. Edison

Edison Batchelor Phono Wks stock—

Feb 10 1913. I took to E H Lewis the following statement, and asked him for his opinion as to whether I had any rights and as to whether I was enjoying all the rights that my agreement conferred after a careful reading of all the agreements referred to in the document— I presuming that his firm had made them all & that they might have copies

Statement of Chas Batchelor in regard to the agreement between Thos A Edison and Chas Batchelor relating to Certain Edison Phonograph Works stock placed in trust with the Mercantile Trust Co of New York.

1 An agreement dated April 8th 1890 between Thos. A. Edison and Chas Batchelor was entered into— the same being drawn up and witnessed by S. B. Eaton.—'Copy of same attached'—

2 Mention in this agreement is made:—

First:— Of an agreement made between T.A.E. and the Edison Phono. Wks. bearing date May 12th 1888.

Second:— Two certain other agreements entered into by T.A.E. & the Mercantile Trust Co. & bearing dates respectively 21st January 1890 and 8th Apl. 1890.

Particular reference is made to all of these in the Edison Batchelor agreement

3. None of the three aforesaid agreements has ever

been submitted to me nor was any of them attached to my agreement.

4 About the date of this agreement, that is April 8th 1890, the Capital stock of the Edison Phonograph Co. was raised from $300,000 to $600,000 and I was entitled to the shares mentioned therein by reason of the fact that my arrangement with Mr. Edison gave me a one tenth interest in all the values received from his invention by him in remuneration for my assistance to him in the invention, development, and commercial building up of the Phonograph, duties which occupied almost my entire time for several years.

5 Dividends were commenced on the Edison Phonograph Works stock in November 1899 and have continued uninterruptedly since — Total dividends to date about 20% ——

6 On or about Nov 13 1899, after receiving my first dividend on stock that I had paid for at the beginning of the Company's career and which stood in my own name, I wrote to Mr. Edison asking for a remittance of my part of the dividend of the stock in Trust, and he replied "I beg to state that the Edison Phono Wks. stock which is held in trust by the Mercantile Trust Co of New York does not draw a dividend until after the other stock has paid a dividend of 20%

7 As there is no reference to deferred dividends in my contract and as the 20% is about paid on the stock I should like to know whether I am entitled to

Anything or not after a full investigation of all the contracts mentioned

Chas. Batchelor

S.

Statement Feb. 12. 1903 by Chas Batchelor made this day ——

On the 16th May 1902 I met W.E. Gilmore on Broadway & we had a talk about Phonograph Works; & at that time I asked him if he knew anyone who would buy my Phonograph Wks stock —

On Oct 2 1902 — I met Gilmore at his office entrance on Chambers St & we walked up to Broadway together —— He then made me an offer from I.A.E. to take my stock in Phono Wks & pay for it at par in Phono Wks 5% Mtge bonds at 70 — I said, well! that is certainly an offer! but does that include the stock that is not in my name & but which I practically own that is in trust at the Mercantile Trust Co.?
He said he did not understand, & did not know that there was any stock other than what they were paying dividends — He said he would ask Mr I.A.E. & write me —

Oct 14th 1902 In a letter to W.E. Gilmore on other matters I reminded him about his promise to let me know about the 'Stock in Trust'

A.B.C. CODE USED
CABLEGRAMS "EATWIS NEWYORK"
TELEPHONE "52 BROAD"

EATON & LEWIS

S.B.EATON
EUGENE H.LEWIS

JOHN C. ROWE
EDWARD G. PRINGLE
H.A. WARREN.

Law Offices

44 Broad Street (EDISON BUILDING)

New York Feb. 11,1903.

Charles Batchelor, Esq.,

52 Broadway, New York City.

Dear Sir:

I think the best way for you to get hold of the two agreements between Mr. Edison and The Mercantile Trust Company, dated respectively the 21st. day of January and the 8th. day of April, 1890, is by application to Mr. Edison or to Gilmore, or with their written authority, by application to The Mercantile Trust Company.

Yours very truly,

Eugene H. Lewis.

EHL/ABT. M.43.

CHARLES BATCHELOR COLLECTION

1892–1905

Indicazioni eventuali abbreviate (Mod. 30)

Indicazioni di urgenza

Urgente	oppure (D)		Posta pagata	oppure (PP)	
Risposta pagata	» (RP)		Posta raccomandata	» (PR)	
Risposta pagata urgente	» (RPD)		Espresso pagato	» (XP)	
Telegramma collazionato	» (TC)		Staffetta pagata	» (EP)	
Avviso di ricevimento	» (CR)		Da consegnarsi in mani proprie	» (MP)	
Far proseguire	» (FS)		Recapitabile aperto	» (RO)	

Ufizio Telegrafico
DI
FIRENZE

Il Governo non assume alcuna responsabilità civile in conseguenza del servizio della telegrafia.
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Pel circuito N.° 77 *Ricevuto* Roma

Le ore si contano sul meridiano di Roma e pei telegrammi interni di seguito da una mezzanotte all'altra.
Nei telegrammi impressi in caratteri romani il primo numero dopo il nome del luogo di origine rappresenta quello del telegramma, il secondo quello delle parole, gli altri la data, l'ora e i minuti della presentazione.

QUALIFICA	DESTINAZIONE	PROVENIENZA	NUM.	PAROLE	DATA DELLA PRESENTAZIONE Giorno e Mese	Ore e Minuti	VIA	Indicazioni eventuali D'UFFIZIO
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Price general 74 1/2 after
641/2 believe company
in strong position
Drexel

Firenze — Tip. Cappelli.

Gehe

Brünn Dec 27th 1892
Am Kiosk 9

My Dear Mr Batchelor

I met Mr Fodor in Vienna the other day; and he told me that you were in Rome, but would leave for America in order to spend the holidays with your family. I wanted long ago to write to you, but I had lost your address, and even now I dont know it, and address this letter to Broad St, hoping that it will reach you. You no doubt have wondered what has become of me: The fact is that I am still here in Brünn, and have been for the last five years again. How often have I thought of you, and those Menlo Park days, and even now looking at "Ganots Physics" beside me the book which you gave me then, recalls those times when life was full of hope, and I was happy.
The reason I came here again, was that I wanted to learn, and advance my knowledge of mathematics a little more, and have succeeded as far as the differential and integral calculus. I have also been studying electricity hard these last two years; I tell you, my dear Mr Batchelor it was hard sometimes, when thinking, that I was alone here, and nearly all those old friends were lost sight off. It seems as if I were in a living grave

here. I never speak English, and my native tongue seems strange. The life here is comfortable enough, but there is a wantage in social intercourse. No doubt it would have been better for me had I gone to America long ago, and it is my greatest desire to be some day with you again. You know when in Paris I was young, and a young man is like a bottle of Soda, lots of gas, and after it has heaved off, things become quiet again. However I have never lost my admiration for Mr Edison and you and Mr Upton and I have often defended our Edisonian principles here. Why aint I a Edison man yet?
You know these Germans dont like to acknowledge the big things due to Edison, why they forget who first subdivided the light, the high res. lamp, the parallel system, the three wire system, the feeder system, the fuse, and who was the first to use massive magnets for the dynamoes. These things of course are common today, but when they were first shown years ago, they criticise them, and today some dont want to acknowledge them as big things.
I made a nice tableau of Edison lamps and various other things of our system for the Polytechnic School here.
When I first came here, I made some business in lamps, machines ect, but now, duty and freight from France prevents anything to be sold, as the opposition companies bid much lower. Seimens has a factory in Vienna with about 1100 workmen.
I am now trying to get the city to take over the theater installation here, and hope to succeed. I myself dont intend to stay here much longer perhaps wait till summer, and then go to America. I should like to get out of Brünn again. I wish you would be so kind and let me know what prospects there are. Is it possible to be by you again? Todor told me you were in the Ore line over here.
You may depend that I will serve faithfully. Francis of old is far more serious now, and has no such illusions as formerly, but aims to please.
You will be so kind also, to speak a good word for me to Mr Edison, who I hope has not forgotton me.

With my best wishes to you and your family, and at the same time wishing you all a happy New Year

I remain Yours faithfully

Francis Jehl

B. Lunds - Perry

THOMAS A. EDISON, PRESIDENT.

CHARLES BATCHELOR, VICE-PRESIDENT.

W. S. PERRY, SECRETARY, TREASURER.

W. S. PERRY, THOMAS BUTLER, SECRETARY.

NEW JERSEY AND PENNSYLVANIA CONCENTRATING WORKS.

GENERAL OFFICES:
EDISON BUILDING, BROAD STREET
NEW YORK.

WORKS:
EDISON, SUSSEX CO., N.J.

NEW YORK, Feb. 7, 1893.

My dear Batch,

Your favor of the 6th enclosing scrip of the Schenectady Railway bonds is at hand. I saw Ord and he said that he did not understand anything about interest and would not pay it. I then told him that you would take his scrip at same price and interest. He declined to sell and in other words will do nothing. While I am writing, I will give you a little private information. Ord bought up yesterday and to-day all the scrip outstanding and has paid 87-1/2 for it, and to make his last $1000. bond, he has to have your $453.90, consequently, if he wants to monkey, if I were you, I should stand pat and tell him when he comes for you next time, that you have raised the price to 90. He will have to have it to make his worth anything. This information you had better keep to yourself. I found it out accidentally that he had bought and paid for all scrip outstanding except yours. I now enclose you the scrip and the next time you send it down to deliver, kindly put your fist on it or your stock could not be delivered.

Yours very truly,

W. S. Perry

Charles Batchelor Esq.,

Edison, New Jersey,

THOMAS A. EDISON, PRESIDENT.

CHARLES BATCHELOR, VICE-PRESIDENT.

W. S. PERRY, SECRETARY, TREASURER.

W. S. PERRY, THOMAS SUTSER, SECRETARY.

NEW JERSEY AND PENNSYLVANIA CONCENTRATING WORKS.

GENERAL OFFICES: EDISON BUILDING, BROAD STREET NEW YORK.

WORKS: EDISON, SUSSEX CO., N.J.

NEW YORK, March 17, 1893.

My dear Batch,

I have not written to you for several days as for the past week I have been rather busy in outside things. The market here has been going to thunder; General Electric on Monday or Tuesday of this week sold down to 98 and under par Drexel, Morgan & Co. bought in the neighborhood of 10,000 shares and the stock then reacted, when that knowledge came out, to 104 but it is now back again to 101. The insiders all insist upon it that it is very, very cheap but Cammack sells it with impunity. The other market has all declined some, sugar going down from 110 to 96. N. Y. Illuminating sold at 20 to-day but is now back to 21. Money is keeping very close, ranging from 7 to 20% every day. That is one reason why General Electric broke so, as the bankers would not loan any money on it and people that were carrying it on a margin were obliged to throw it over.

I sold yesterday for Mr. Kruesi three of his Schenectady bonds and I paid the bankers who are loaning him the money on them $2500. on account and Kruesi tells me that he is going to borrow of you either $11,500. or $12,000. on 15 of the bonds instead of

$14,000. on 18. I told them that it would be perfectly agreable to you and after my conversation with you, I was satisfied that the less money you had to loan to Mr. Kruesi, the better you would be satisfied. I am in hopes of selling three more between now and the 23rd. If I do, he would only have to take $9,000. from you.

I have seen Edison two or three times since you left and he has taken your leaving very much to heart. He made the remark that it was the first time you had gone back on him. I told him that I had told you what he said so that if you wish to repeat our conversation to Mr. Edison, you are perfectly welcome to. He says that from the middle to the last of next month that he would need you more than at any other time as that is the time when all the plans will be finished and will have to be talked over and he was in hopes you would have been here to have your opinion. I told him that you thought that you could be of more service later in the season in buying goods than in looking over the plans. He is progressing pretty rapidly now with the plans and is to have Thomas and Conley down at the Laboratory next week. and he says he thinks that by the 20th of April they will be ready to orer goods. He claims that he has now gotten the bricker in fine shape and the bricks so that they will not absorb moisture and yet are still porous. I don't understand how that can be but he says it is so.

As I told you before you left, I will make an assessment on the N. J. & Pa. Con/ Works for the 8th of April. Your share will be $110.

They are all sick up at 34th St. My wife seems to be badly run down; the two oldest children are in bed with the grip and Clinton McKesson and his sister Belle are both confined to the house, but the old gentleman is as chipper and lively as ever I trust you found Mrs. Batchelor and the girls well when you met them at Naples. I see by the papers that you had a fair average trip, reaching Naples on time, so I presume you did not meet with a storm on the way. I cannot think of anything more at present to write you but will write you next week.

Yours very truly,

W. S. Perry

Charles Batchelor Esq.,

Rome, Italy.

THOMAS A. EDISON, PRESIDENT.

CHARLES BATCHELOR, VICE-PRESIDENT.

W. S. PERRY, SECRETARY, TREASURER.

W. S. PERRY, [redacted] SECRETARY.

NEW JERSEY AND PENNSYLVANIA CONCENTRATING WORKS.

GENERAL OFFICES:
EDISON BUILDING, BROAD STREET
NEW YORK.

WORKS:
EDISON, SUSSEX CO., N. J.

NEW YORK, March 27, 1893.

My dear Batch,

I am sorry to have to write you that last night while taking my usual Turkish bath I slipped on the marble floor and in trying to save myself, fell with my right arm under me and broke it just above the wrist so I presume I shall be in a measure laid up for some weeks and although I hope to be down to the office before this week is out, I will not be able to do any writing.

I delayed writing you last week, as I expected to either see or hear from Kruesi in relation to his getting the money that you loaned him, from D. M. & Co. About the last of the week, I received a letter from him from Schenectady stating that he had notified D. M. & Co. to pay Lazard the amount of his note and to receive the bonds from them. He had also notified Lazard to deliver the bonds to D. M. & Co. and receive a check from them. He did not tell me the amount of the note but my impression is that it was $14,300. on which I had paid $2500., leaving a balance of $11,800. Of course, this way of doing the transaction was different from what we had talked over but as the transaction was finsished before I heard of it, I have said nothing to Mr. Kruesi about it.

I do not know how many bonds he has deposited with D. M. & Co. He had 19 left; I presume he would expect to deposit 15.

There is nothing doing here. We have had quite a flurry in the stock market; Edison General, as I wrote you in my last, selling down to 98; it has since rallied to 107. Last week there was a meeting of the Directors and they ordered to be declared the usual quarterly dividend of 2% payable on the 2nd of May. That will be officially declared and will be know to the Street the middle of this week. The statement, they tell me, is very fine, showing great earnings. The short interest in the stock is still large. I would not be surprised to see quite a rise in it during the next few weeks.

The Journal of Finance which is sent you every day has this morning a long article in which they claim that Edison has sold 35,000 shares. That, of course, as you know is nonsense. He has not done anything since you went away and when I was out there last, he was very anxious that I should not make another assessment very soon as he did not wish to have to sell any General Electric at low prices.

They are hard at work out at Orange on their plans and this week both Mr. Conley and Mr. Thomas are to be there discussing the plans.

Mr. Edison seems to think that by the middle or last of next month we will be very busy ordering machinery .

I have just this morning received the address of the gentleman in Portugal of whom my father got his port and I am going to write him to-day ordering a one quarter cask for us. I fancy we will get it some time in June. The Marsella has arrived and I am having it bottled and when cased, will send up one half of it to your house. The address of the port is Tolades & Co., Lisbon, Portugal. They are old bankers and were quite intimate with General Lewis Richmond when he was the American minister there. I send you this address as it might so happen that you will be in that part of the world before you come back. If so, look them up. Possibly a personal interview would enable us to get better stuff than by simply writing but I intend writing by this mail for the stuff so you will probably not go there.

They are all pretty well here at the house and are gradually recovering from the shock which they received from the death of Mrs. McKesson.

With kindest regards to Mrs. Batchelor and your daughters, believe me to be,.

Yours very truly,

W. S. Perry
by Alfred Peckham

Charles Batchelor Esq.,

Rome, Italy.

THOMAS A. EDISON, PRESIDENT.

CHARLES BATCHELOR, VICE-PRESIDENT. | W. S. PERRY, TREASURER. | THOMAS BUTLER, SECRETARY.

NEW JERSEY AND PENNSYLVANIA CONCENTRATING WORKS.

GENERAL OFFICES:
EDISON BUILDING, BROAD STREET
NEW YORK.

WORKS:
EDISON, SUSSEX CO., N. J.

NEW YORK, April 18, 1893.

My dear Batch,

Your favor of April 1st as well as your cablegram is at hand. Your letter rather disappointed me. I thought when I received your cable that the next thing would be that you would be looking in upon us, but on receipt of your letter, that idea was knocked in the head as you don't seem to have set any time for coming home. I told Mr. Edison that I had received a letter from you but that you had not set any time for coming and he seemed to be much disappointed for on receipt of your cable. He said, "well, Batch will be here now in a steamer or two". They are getting the plans about finished now and Conley is hard at work up at Edison with a large gang of men putting in the railroad tracks and getting ready to erect the new stockhouse. He says that all the outside work of every particular will be finished by the 1st of August. But Edison says that it will be September or October before the Mill will be ready, but he is satisfied in every particular. His plans, he knows, are very fine and that all of them will work well and give good satisfaction.

I note what you say in your letter with regards Baldwins. I have put your check in the safe and when they notify us, Ed. and myself will go around there and examine the pictures, and if they are all right, will have them boxed up again carefully and sent to your house. I will also attend to your package of books. I note what you say with regards your $1200.00 check. When I received it, I told Mr. Edison that you had sent the money for 12 shares instead of 11 and he said, all right, let him have them, so that your certificate is all drawn, signed and sealed and is in the safe for you. If you don't wish the extra share, on the next assessment which will be about the 12th of May, I will draw only 10 shares instead of 11.

The bottler told me this morning that our Marsella would be ready this week so I will have one half of the quarter cask sent to your house and one half to mine. I have not heard as yet from Lisbon about the Port wine but I presume some time this month I will hear about it.

Insull was on last month and got your address in Rome as he said he wished to write to you so I presume you have heard from him ere this. I heard from him this morning and he said he was very well and liked Chicago better and better the longer he stayed there.

We are to have the Annual meeting of the N. Y. Concentrating Works on the First Monday in May and Mr. Edison told me to re-elect the same board of directors, the same officers with the exception of Mr. Butler whom I am to replace as Secretary and be Treasurer as well.

With kindest regards to Mrs. Batchelor and the girls, believe me to be,

Yours very truly,

W D Ray

Charles Batchelor Esq.,

Care Drexel, Harjes & Co.,

Paris, France.

THOMAS A. EDISON, PRESIDENT.

CHARLES BATCHELOR, VICE-PRESIDENT.

W. S. PERRY, TREASURER.

W. S. PERRY, SECRETARY.

NEW JERSEY AND PENNSYLVANIA CONCENTRATING WORKS.

GENERAL OFFICES:
EDISON BUILDING, BROAD STREET
NEW YORK.

WORKS:
EDISON, SUSSEX CO., N. J.

PERSONAL

NEW YORK, May 10, 1893.

My dear Batch,

Your favor of April 25th written from Naples is at hand. I have just received a letter this morning from Knauth, Nachod & Kühne stating that your statue has arrived. Ed went down there this morning but they said it would be several days yet before they could get it out of the Custom House and they advised us to have it sent up to your house before being unpacked and examine it there, and if all right to pay them, as they probably would not be able to pack it well. Your check for $156.00 is the correct amount. Your package of books arrived some ten days ago and was sent to your house and I paid Baldwin's bill of $18.75, some $7.00 of that being for duty, but according to your last letter, you told me not to dispute a small amount so I said nothing about it. The pictures have not arrived yet. When they do, we will examine them and pay the check that you sent to me over to them.

I have my arm now out of the splints and it seems to be doing very well but I have not as yet been able to use it, but the Doctor says that I ought not to expect to for two or three months yet.

They are all well at 34th St. and Mrs. Perry wished me to send her kindest regards to you and yours. They are not feeling particularly happy at present as a Mr. Vennard who married one of my wife's sisters is very seriously ill with heart disease. It always seems that after one death in a family, two or three others follow quickly.

Mr. Edison is well; the other day when I saw him I told him that you had written t at you might be back about the 1st of June and he said that was the best news he h ad heard for some time and wished I could come out every day if I could bring him such news as that. His plans are all finished now and he says he is getting out the blue prints in order to ask for bids on the different parts of the work. He claims that he has gotten great deal better results from the rolls than he expected to get, that the screens are perfect, in fact, that the whole thing is getting to be a great success.

Upton has been very seriously sick for the past two weeks with diptheria but the news to-day is, that he is better so I presume he will pull through all right.

At the Annual Meeting of the N. Y. Concentrating Works the other day, the same directors were re-elected for the ensuing year but no officers were elected as there was not a quorum of directors present. But I fancy we will do that tomorrow out at Orange as Mr. Cutting is to go with me and that will make a quorum.

Yours very truly,

W. H. Perry

We have been having great times here in Wall St. during the past ten days. All of the Industrial stocks have had very severe declines, Edison General selling down one day to 58 but rallied next day to 84 but is now down again to 70. Mr. Edison says that the reports he gets every week from the Company are exceedingly satisfactory, that the business is larger and is paying better or in other words, they are earning more money now than they ever have done. They tell me at the office here that the Co. is in good financial condition, with plenty of money on hand. Therefore I dont suppose there is any reason for the drop other than than gra depression in all Industrials. Quite a number of financial institutions have declined to lend money on that class of securities which probably forced a good many men who were holding the stock on margins, to liquidate. The N. Y. Illuminating sold down to 110 but I believe it is to-day about 117.

W. S. Berry

5656

TÉLÉGRAMME

BATCHELOR HOTEL ANGLETERRE CONSTPLE -

Il n'y a rien à payer au porteur

Reçu de 17 201		Expédié 8h
Le 15/1 189		Le 18/5 189
مأمورك امضاسى		مأمورك امضاسى
L'Employé 18	Dépôt le ساعت كيجه وياكوندز دقيقه à h. m. du	L'Employé

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Dans les dépêches imprimées en caractères romains par l'appareil télégraphique, le premier nombre qui figure le nom du lieu d'origine est un numéro d'ordre, le second indique le nombre des mots taxés, les autre désignent la date et l'heure du dépôt.

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تلغرافنامه

Reçu de

فی — سنه ۱۳۰

Le — 189

مأمورك امضاسی

L'Employé

TÉLÉGRAMME

BATCHELOR CARE CONSUL GENERAL

UNITED STATES CONSPLE

عن

صاحبنه ارسالی

Expédié

فی — سنه ۱۳۰

Le — 189

مأمورك امضاسی

L'Employé

مخابرات تلغرافیدن طولایی دولت هیچ بر کونه مسئولیت قبول ایلمز

L'état n'est soumis à aucune responsabilité à raison du service de la correspondance par la voie télégraphique.

- PARIS 46504 24 10 M ILLUMINATING · CLOSED · YESTERDAY AT 113 GENERAL

75 1/2 GAS 74 CABLE RECEIVED TODAY MARKET STRONG TROUBLE OVER · - MACRUM · +

نمونه ۲

Dans les dépêches imprimées en caractères romains par l'appareil télégraphique, le premier nombre qui figure le nom du lieu d'origine est un numéro d'ordre, le second indique le nombre des mots taxés, les autre désignent la date et l'heure du dépôt.

ARNOLD, CONSTABLE & Co.
New York
Paris, 21 rue d'Hauteville.
Lyon, 8 Quai St. Clair.
Manchester, 41 Lower Mosley St.

A Heavy Sale of Edison Stock.
The General Electric Company has sold its entire holdings of the Edison Illuminating Company's stock, amounting to $1,500,000 to Kuhn, Loeb & Co., who have taken it on behalf of a European syndicate at a price of about $110 a share.

Paris Monday May 29

Dear Mr Batchelor

Yours dated May 26 received. I think as you do. Our brokers pretend they know but they don't. They have been buying and losing right along for me. It will take me years to get out of debt. If Edison Ill makes a brake I will be still worse as I am holding on, thinking it will go up 8 or 10 points. The Gold sold down to 65 on Saturday. They must have hard work to negotiate their papers. Still 1,500,000 should give them a good lift. I cut the enclose slip out of lost unless paper for you. If I ever get square I will keep out of Wall St. Kind regards to me and hoping to see you soon, I remain

Yours truly

J. M. Young

Please address all communications to Edward Stanford.

26 & 27, Cockspur Street, Charing Cross.
London, S.W. June 15th 1893.
(Formerly at 55, Charing Cross)

SOLE AGENCY,
ORDNANCE SURVEY
ENGLAND & WALES.

Dear Sir,

I beg to acknowledge your inquiry of the 14th. about discount. Whatever New York booksellers may do – & from my knowledge of them I should question your statement that they would give away their trade discounts – I do not give discount on my maps to anyone unless legitimately in the Trade. Whether you can get my spring roller mounting at all, much less cheaper, in New York is also a question. But the quality of the maps is undeniable, & I hope you will allow me to sell them to you at any rate in sheets at the catalogued prices.

Enclose my terms card & beg to remain

Yours faithfully
Edward Stanford

Charles Batchelor, Esq.

Ad Rinson

UNION SQUARE HOTEL

ANDREW J. DAM.
GEORGE H. DAM, SECRETARY.

J. H. Dam, Manager.

HOTEL DAM

CONNECTING.

UNION SQUARE & 15th ST.

New York Sept 14 1893

Chas Batchelor Esq
23 West 25th Street N.Y.

Dear Sir:

I called upon you at Edison B.Y. today with the enclosed note of introduction from my friend J. Pipes of London. They informed me that you had gone to Chicago, I must have passed you on the way having just returned. I am sorry to have missed you and hope to have the pleasure of seeing you on some future occasion.

Yours faithfully
Dewey B Atkinson

[ENCLOSURE]

PRIVATE LINE BETWEEN HEAD OFFICE & PONT STREET.

SHARP AND KENT.
Engineers & Electricians.
TELEGRAPHIC ADDRESS "MEGAVOLT, LONDON."
TELEPHONE Nº 3125.

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PONT STREET, S.W.
& 2, TOLLINGTON ROAD, N.
Central Lighting Stations,
SLOANE SQUARE, S.W.
& HOLLOWAY ROAD, N.

Connaught Mansions,
34, Victoria Street,
Westminster, S.W. Aug. 10th 1893

Chas Batchelor. Esq.
23 West 25th Street
New York.

Dear Mr Batchelor,

The bearer is Mr. L. B. Atkinson, member of the firm of Messrs Goolden & Co London. & a personal friend of mine. If you can get him permission to see any Electrical works in your Country I should feel much obliged. Hope you will let me know when you are next in London

Yrs very truly

E. Grant Pipes

W. Luttken

11 Birchin Lane
London E C
Feb 27. 1894

Dear Sir,

I have been advised by some Manchester friends to write you in reference to my son (Age 19) for whom I am endeavouring to obtain a situation in an Electrical Engineering Works - he gained a Scholarship at School which afterwards enabled him to study Electrical Engineering at the Finsbury Technical College under Professor Sylvanus Thompson (Copy of whose testimonial I enclose) - he has since been out to South Africa & back as a junior Electrician on the

"Great Northern" & "John Pender" Telegraph Ships belonging to the Eastern Telegraph Co & is at present working for the Co't at their Office in London. but feels very unsettled as he has always had a great desire to get into an Electrical Engineering Works - he has made many applications in this Country but all require a large premium as a Condition to an Engagement & that I am unable to pay.

You may possibly remember me by name in Connection with the Cheetham Hill Church & School in the late Mr Conders time, but I understand from my Wife (formerly Miss Harriet Draper) you knew her & her brother George Well when living at Cheetham Hill -

Yours truly
W Dutton

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[ENCLOSURE]

Technical College, Finsbury
London E.C. Oct 22 1892

Mr G. H. Dutton worked for two years in the Electrical Laboratories, Workshops & Drawing Offices of the Technical College Finsbury during the sessions 1890-91 and 1891-92. He was a diligent & intelligent student & gave entire satisfaction in conduct throughout his career. He acquired a fair knowledge of draughtsmanship & is competent to undertake all ordinary kinds of electric testing, or to take charge of running machinery dynamos & electric lamps, of the management of which he has had some useful experience

(Signed) Silvs P. Thompson
Principal &
Professor of Physics

Gladstone

110 East 23 St N.Y.

March 10/94.

Dear Mr Batchelor,

As our subscription list is not yet filled, I am sending you a course ticket in accordance with your request - Mr Upton is also a subscriber -

Yours truly

J.W. Gladstone.

Friends - Thomas E.W

April 9th 1894.

45

My Dear Mr. Batchelor

In bidding adieu to mechanical line of employment it is fitting I should express my intentions to you, to whose kindness and judgment I owe what success I may have attained or profit derived from such employment.

In considering the unpleasant later portion of my Edison service and its unsatisfactory 'termination, and after making full allowance for whatever might have been due to my own faults, I cannot escape the conclusion that the position embodied more risk of ultimate dissatisfaction than a young man should be called upon to assume.

While the very peculiar business relations existing between the heads of departments as Edison will probably not be found in any other mechanical industry, still the fear of encountering anything approaching, in repugnance, those relations, has influenced me in discarding the mechanical line and selecting

medicine as the means of obtaining my future livelihood. A two years experience in the drug business, combined with other considerations that would require too much time to mention, do not make my selection of medicine as odd as might at first appear.

I hope to make a respectable representative of the profession and to merit the regard and kindly interest you have extended me in the past.

I matriculated a month ago but will not begin the college course at Jefferson Medical College until Sep. - until that time I shall study under a preceptor here.

Trusting I shall be retained in kindly remembrance - I am,

Very sincerely yours,

D. H. Clemens.

St. Clair
Penna.
Box 158

33. Snow Hill.

London E.C. June 7th 1894

My dear Charley

I never write unless it is to get something out of you, but I know you are good-natured enough not to mind being bothered in these matters. I am going to ask you now if you can kindly assist me in the way of giving an introduction to a Nephew of mine who is interested in Electrical Engineering. I enclose a copy of testimonials, I may here mention that Andrews & Co is a business bought up and worked by Sharp & Kent, I think you met another nephew of mine (Piper) there when you were in England. My Nephew (A Rolfe) on whose behalf I now write was with this firm for a short time but left for private reasons not connected with the business. I thought perhaps, you being so well known in the Electric World would kindly be able to give him an introduction to some firm over here, which would be of great assistance to him, but he is quite willing to try New York if you think that the chances are better out there than over here, I think he is a young fellow that will get on, he also has some knowledge of machinery, & counting from work. And I know you will kindly say a word for him when you can, and it is just this that sometimes gives one a fair start. I was very pleased indeed to have seen Lord again

after so many years, he called here a few weeks back, and came down to Wormley and spent a couple of nights with us, he appears well and I hope will be running up to London occasionally, we hear from Emma & Harriet now and then they are just now getting busy, I wish they could come and see us in the summer I hope Mrs Balchelor and your family keep well, All at Wormley join me in kind regards to Mrs Balchelor and yourself and thanking you in anticipation believe me

Yours faithfully
Hugh Rolfe

C. Balchelor Esq

Mr Hodge

Aug 20th/1894

This is very late to be answering yours of June 7 but I have been away ~~most of the time~~ & everybody else being on vacation it has been difficult to do it before.

I have just now got a letter from Mr. Kruesi the General Man. of the Gen' Elect Co at Schenectady N.Y. (which was the Edison business I started in 1880) & which now employs about 4000 men & does most of the best work in this country. He says "If you will send the young gentleman here with a letter from you I will do the very best I can for him" He also adds "let me know when he comes what you regard as most suitable for him"

I do not know what his prospects are over there but my opinion is that any young man with ability and push can do better in the

electric line here than there, not because I think the American is any more thorough than the Eng but because we are more speculative here & that makes work plenty & positions better paid whether there is immediate money in it for the investor or not.

I do not think a letter from me would be worth anything in England. ~~as~~ I never did any work there & am only known by very few ~~there~~ & by them only as an assistant of L.A.E. I have no personal friends in the Electrical line there —

If he should decide to come Give him A letter to me & I think he will be satisfied that he has made no mistake

We have just been through the hardest time I have ever seen in this country due to the fact of a change of administration to one in direct opposition to the one that has prevailed for the last

20 years — It has so unsettled business that the year 1893-1894 is one continuous record of failures & bankruptcies — A policy has at last been decided upon ~~which gives confidence to the~~ ~~of trade investor~~ which if it does not give the investor all ~~what~~ he wants at least it gives ~~a return of~~ confidence. In consequence ~~&~~ we see a return of trade as quick as beneficial ~~as the stomach of the Channel passenger returns to hunger after a particularly disagreeable voyage & reminds me of the state of~~

I had a letter from Lom the other day but he did not say anything about being in London He seems to be getting along pretty well & has about all his boys now out in business —

Mrs Batchelor joins me in kind remembrances to Mrs Kolb your son & daughters & believe me Yours truly C.S.

(1894)

Sept 19

My dear Gilmore,

I know by this time that your method & work at the Phonograph Works must have shown some fruit although I dont suppose it will be tabulated until the end of the year — As soon a little of the stock I wish you would let me know privately your opinion at present whether it will ever get on a paying basis & how long you expect it to be before ~~doing so~~ it is in that condition — The figures are confidential of course

Balch

EDISON PHONOGRAPH WORKS

Orange, N.J. Sept. 24, 1894. 189

Chas. Bachelor, Esq.,

#23 West 35th st., N. Y.,

My dear Bachelor:-

I have your letter of the 19th. I see no good reason why the Works should not be put on a paying basis. Of course, we are not over busy now, but if Mr. Edison ever gets controll of the Phonograph in the United States and Canada, which we expect he will, then there is no reason why we should not fill up the shop with work in this line, to say nothing of the new things that we expect to take up shortly. I regret to say that I am not in a position to give you any figures as to how we stand at the present, as I do not consider them sufficiently authentic to be of any use to you, or in fact anyone else, and I know that they will be far from satisfactory. The next time I see you, I shall be very glad to answer any questions that you may ask me, and I think I can give you a pretty good idea as to how matters stand.

Yours very truly,

A. O. E. Glenwood

WEG/IW

General Manager.

HOUSTON & KENNELLY,
ELECTRICAL EXPERTS
AND
CONSULTING ELECTRICAL ENGINEERS,
OFFICES, 1105-1106 BETZ BUILDING.

CABLE ADDRESS "HOUSKEN, PHILADELPHIA."
METALLIC CIRCUIT TELEPHONE No. 3037.

PHILADELPHIA, 29th Nov. 94

Dear Mr. Batchelor. -

The best men in the Electro-Therapeutic specialty residing in New York are I think

Dr. W. J. Morton Specialty - Neurologist Hours
19 E. 28th St. 10 — 1

Dr. Aug. H. Goelet Specialty. Gynecology
351 W 57th St

Among women (Doctresses)
Dr. Margaret A. Cleaves
68 Madison Ave.

These physicians I am personally acquainted with, and am convinced of their ability. If however they are not accessible, consult Gladstone at the Edison Office 110 E. 23rd St. who knows a good many.

I am sorry that Mrs Batchelor is under the weather but I trust that you will be able to restore her to perfect health. Will you please remember me kindly to her, and also to the young ladies.

With all good wishes

Yours very sincerely
A. E. Kennelly

of all noxious elements, and turned into steel in some-thing less than an hour.

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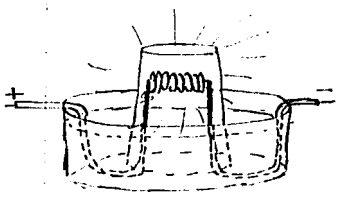
3 Incandescent Lamps. Groves 1845 Feb 1895

William Robert Grove in a letter to the Philosophical Magazine of London which was published Dec. 1845 describes an incandescent lamp that he made & by the light of which he has read & experimented for hours. Previous to that time there had been a desire to get a miner's lamp that could not be tampered with. De La Rive, M. Bousingault, & Mr Grove had been working with a view to using the voltaic arc ~~in an~~ enclosed in a glass globe for this purpose – After enumerating a few of the difficulties that they met with he says:– "I substituted the ignition of a platina wire for the disruptive discharge.



Any one who has seen the common lecture-table experiment of igniting a platina wire by the voltaic current nearly to the point of fusion, will have no doubt of the brilliancy of the light emitted: although inferior to that of the voltaic arc, yet it is too intense for the naked eye to support, and amply sufficient for the miner to work by. My plan was then to ignite a coil of platinum wire as near to the point of fusion as practicable, in a closed vessel of atmospheric air, or other gas and the following was one of the apparata which I used for this purpose, and by the light of which I have experimented and read for hours:– a coil of platinum wire is attached to two copper wires, the lower parts of which

or those most distant from the platinum, are well varnished; these are fixed erect in a glass of distilled water, and another cylindrical glass closed at the upper end is inverted over them, so that its open mouth rests on the bottom of the former glass; the projecting ends of the copper wires are connected with a voltaic battery (two or three pairs of the nitric acid combination), and the ignited wire now gives a steady light, which continues without any alteration or inconvenience as long as the battery continues constant, the length of time of course being dependent upon the quantity of the electrolyte in the battery cells. Instead of making the wires pass through water, they may be fixed to metallic caps well luted to the necks of a glass globe.

The spirals of the helix should be as nearly approximated as possible, as each aids by its heat that of its neighbor, or rather diminishes the cooling effect of the gaseous atmosphere; the wire should not be too fine as it would not then become fully ignited; nor too large, as it would not offer sufficient resistance, and would consume too rapidly the battery constituents; for the same reason, i.e. increased resistance, it should be as long as the battery is capable of igniting to a full incandescence. The helix form offers the advantages, that the cooling effect being lessened, a much larger wire can be ignited by the same battery; by this increased length of wire, the battery fuel is economised, while a greater light is afforded; by the increased heat, the resistance is still further

increased, and the consumption still further diminished so that, contrary to the usual result, the increment of consumption decreases with the exaltation of effect produced. The very necessity of inclosing the coil in a glass recipient also augments the heat, the light & the resistance etc etc." He also experimented with different gases in the enclosing globe & gave the results & told of his intention to continue these experiments to other gases and rarefied air—

:4 Incandescent Lamps. p 428. Feb. 1895.

Geo B. Prescott in his "Speaking Telephone, Talking Phonograph, and other novelties" 1878 says:—

"The best means however, for obtaining a number of lights from a single source consists in the employment of thin strips of platinum or Iridium, whose temperature is raised by the passage of the current to a point only slightly below the melting point of these metals. When strips or wires of either metal are rendered incandescent, a mild and pleasant light is emitted, much less contracted and glaring than the light obtained from carbon pencils and with the additional advantage also, that no vitiation of the atmosphere occurs, and the amount of light, at any one point, can be made as small as may be desired— Platinum according to Mr Farmer affords about 100 candles light per square inch of incandescent surface when within 220° of the point of fusion, and a bar or wire of this metal can be maintained at this temperature for any length of time by means of a suitable regulator and current. Iridium is even better adapted

for illuminating purposes than platinum, as, in consequence of its higher melting point, it yields more light per square inch of heated surface.

In the edition of 1879, p. 515 is published a letter of Moses G. Farmer who says:- In the summer of 1858, while reading of the very interesting experiments of Prof. Draper on the heat and light produced by a platinum wire, which was traversed by an electric current, I was struck by the rapid increase in the amount of light given out as the temperature of the wire approached the point of fusion, and it struck me that, if the temperature of the wire could be steadily maintained quite near the melting point, a useful light could be obtained from it. I was not long in devising a combination of electro magnets, rheostats and batteries that would give the desired result, and early in 1859 I put the idea into successful and practical execution, and we had a beautiful light in use in my house in Salem. I at once entered upon a protracted investigation of the conditions which govern the management of the current the construction of rheostats, the arrangement of lamp etc, and the best proportion of length, width, & thickness of the illuminator. I tried various substances in the course of my investigations such as copper, aluminum, platinum, iridium, palladium, iron, nickel, carbon, etc.

Pure iridium gave the best results of any of the metals. Alloys of iridium and platinum gave next best results, and next to this platinum and

palladium. Carbon when enclosed in an atmosphere free from oxygen, also gave satisfactory results. Nitrogen, Carbonic oxide, and hydrogen are all suitable gases to surround the incandescent carbon. A vacuum is perhaps better, were it not for the difficulty of maintaining it. The important point is, that the higher the temperature of the incandescent substance the greater amount of light; and it is very noteworthy, that it requires nearly half as much current to make platinum shine in the dark as it does to fuse the wire or ribbon. Three quarters of the fusing current will not give one half the light that will be given off by seven eighths of the fusing current. A flat ribbon of platinum will give nearly one hundred candles per square inch, if it be maintained within two hundred degrees Fahrenheit of the melting point, and I have been able to keep it at this temperature for hours and days. A bar of pure iridium, owing to its higher melting point, will give several times as much light as an equal & equally exposed surface of platinum; but since pure iridium is neither malleable nor ductile when cold, it is costly to work it into convenient shape; hence, I have had recourse to alloys of platinum and iridium, which, although they do not give so much light as pure iridium, are yet superior to pure platinum. The platinum does not seem to waste perceptibly, yet I think I have detected a tendency to volatilisation.

The resistance of platinum, at the melting point, is nearly seven times its resistance at thirty two degrees Fahrenheit. xxxx I found no difficulty in subdividing the current into as many branches as I pleased, and in maintaining as many lamps as I desired in each branch, provided I had, at my control sufficient electro motive force and conductivity. I found that less than 200 foot pounds per minute would maintain one candle light, if the piece of platinum were of suitable form and dimensions. It was easy to supply current to any desireable number of branches, and to so adjust the regulator, that, if one, two or three of the branches were removed or cut off, the supply of electricity would be so curtailed as to maintain, at the proper temperature, the lamps in the remaining branches. My regulator, as I used it in 1866, 1867, & 1868 was so sensitive as to feel the current of air arising from the opening & shutting of a door of the room in which the apparatus was placed.

I had this apparatus on exhibition at 109 Court Street in Boston during the years 1865, 1866 1867 & 1868 until it was destroyed by fire

Incandescent Lamps. A. Lodyguin of Petersburgh.

Russian paper Golos #129 May 11-23. 1873 — the following is translated from an article herein :- "On Tuesday the 8-20 May a most interesting trial was made for the first time in public at the Admiralty House. St Petersburgh under the auspices of Messrs S. A Koloff & Co, the proprietors of the patent, of a new system of lighting by electricity, the invention of Mr A. Lodyguin of that town. xxxxx By his newly invented method, only one piece of charcoal or other bad conductor is required, which being attached to a wire connected with an electromagnetic machine is placed in a glass tube, from which the air is exhausted, and replaced by a gas which will not at a high temperature combine chemically with the charcoal. This tube is then hermetically sealed and the machine being set in motion by means of a small steam engine the charcoal becomes gradually and equally heated and emits a soft, steady, and continuous light, which by a most simple contrivance can be strengthened or weakened at the option of those employing it: its duration being dependent solely on the electric current, which of course will last as long as the machine is kept in motion —

Taking into consideration the fact that one machine, worked by a small three horse power engine, is capable of lighting many hundreds of lanterns, it is

evident what an enormous advantage & profit could be gained by the illumination of streets, private houses, public buildings, and mines with the new electric light. In the latter it must prove invaluable, as no explosion need ever be feared from it, and these lanterns will burn equally as well under water as in a room. Without mentioning the many advantages this mode of illuminating has over gas, which by its unpleasant odour and evaporation is slowly poisoning thousands of human beings, and from which explosions are frequent, we can state that by calculations made, this electric light can be produced at a fifth the cost of coal gas — Jour. Soc Arts Aug 22 1873 Vol 21. 779.

253 Incandescent Light Soc of Arts July 30 1875

Lodyguin's light. In an article on illuminating by Electricity Mr Lodyguin's light is thus described:— "Mr Lodyguin employs a short stick of charcoal in a single piece, and reduces the area of its section between the two electrodes in such a manner that it offers considerable resistance to the current; so that the portion between the poles, being heated to a high degree, becomes luminous just as a metallic wire would do. The lamp consists of a cylindrical glass vessel, closed with metal covers so as to be air tight both at top and bottom. Occupying the centre of this cylinder is the stick of charcoal held in its place by two pieces of metal communicating, through the covers with the two electrodes of the battery. In order to render the

light more intense, several sticks of charcoal may be placed in the same lamp; the conducting wire which leads the electricity from the battery communicates with an insulated rod connected with the cover and in contact with the first piece of charcoal; the electric current then passes into the second piece of charcoal through the lower cover, and from thence to the next lamp, or to the battery. On account of the heating of that part of the charcoal which is reduced in thickness, the surface rapidly becomes oxidised when in contact with the oxygen of the air, and the charcoal is consequently worn away, a circumstance which would tend to considerably limit the duration of the lamp — To avoid this drawback however, the lamp is filled with Nitrogen, which is prevented from escaping by the two air-tight covers; in this ~~manner~~ manner oxidation cannot take place and the pieces of charcoal preserve their original dimensions — The inventor has been awarded the Lomonossoff prize by the St Petersburgh Academy of Sciences —

---

4 Subdivision of Electric Light — W. H. Preece in discussion of Shoolbred's paper on Application of Electricity to Lighting purposes before the Society of Arts London Dec 6 1878 said:- "He looked upon the Subdivision of the electric light as a practical impossibility xxx. He did not know much about this Edison light, but he knew Mr Edison. He visited him in America some two years ago, and spent two very pleasant days in Mr Edison's

laboratory. He was an extremely ingenious man, but his ingenuity often carried him to extremes. He was an American of the Americans. It was said of an American infant, that he would improve his cradle, get out and patent it, and get back again. Mr Edison had taken out 269 patents but he only knew of three that were at work. Not having seen Mr Edison's light, he could not say very much about it but he feared he had tumbled into a tremendous mare's nest and that with two 80 H.P. engines and a lot of money he was going to flounder out of it. He thought that it was not in the shape of subdivision but of condensation that the light would be improved and made fit for use "etc etc

---

55 Incandescent Light. Mr H. Preece's doubts about its subdivision. In a lecture before Society of Arts London (Juvenile Lectures) January 9. 1880 he said:-
"A great deal of nonsense has been talked about electricity and gas. We have been startled lately by telegrams from the other side of the Atlantic; and to those who can read these telegrams properly, they announce nothing but the most outrageous nonsense. We have a correspondent of one of our papers, telegraphing across the Atlantic that an electric lamp has been produced which gives for 10d, a light equivalent to ten thousand cubic feet of gas. Now ten thousand cubic feet of gas cost £1.10s where I live and to produce anything in the form of an electric light which would do as announced would certainly

be a great wonder. But in the first part of this self same telegram it is said that Mr Edison has produced a light which gives only 16 candle power and that one horse power will maintain eight of these lights going. To some this may seem a very extraordinary fact, but to us, who know something about gas and electricity, it is by no means so, for we know that in this city of London we are, at this moment, producing ten times the amount of light per horse power by electricity. Siemens produces in his machine exactly ten times the power of the light recently produced in Newyork. But more than that, gas itself does just the same as this vaunted light is not more. The amount of coal consumed in producing one horse power – three pounds weight – will produce 14.2 candles power by gas. So that taking Mr Edison's machine of one horse power as maintaining eight lights of sixteen candle power each, producing a total of 128 candles, the startling announcement in its result comes out actually below the candle power in gas produced by the same quantity of coal; and hence this wonderful discovery that sends our gas stock down, I dont know how many per cent. is really worse in candle power than the gas we burn in London

29 Electrical Incandescence - Edison Light Jan 1895.
Articles N.Y. Herald 1880. Jan 4 page 4, 5th Sawyer controversy p. 2
Nulling letter 2. and editorial, Jan 6th Sawyer cont. p. 8, Jan 8th
page 6, Dutmoncel's letter p. 7, Jan 9th p. 6 — Jan 10th p. 2. 10 —
Jan 11th p. 11 — Jan 12th p. 7 — Jan 14th p. 10. — 18th p. 11 —
20th p. 8 — 23d p. 3. 6 —
Mch 24th p 8 — 25th p. 10 — 27th p. 8 — 30th Sawyer cont'y
p. 11 —

22

57. Electric Lamps for Mines.
De la Rive's two points or cylinders of coke hermetically sealed in a glass balloon, no vacuum because the incandescent coke quickly absorbs the oxygen preparation of the coke is very important.
Cow. Rend. Sep 15 1845 — Phil. Trans. Ser. 3 Vol 27 406

58. Incandescent Lamps Dec 1845
Grove's exp. on incandescent platinum in gases. He shows the advantage of making a spiral form instead of straight, and also the advantage of greater resistance to be got by spiral form
Phil. Trans. Ser. 3 Vol 27. 4

Description of Young & Delcambre's composing machine in Ill. London News Vol 1 1842 23 & 413.

53 Tulipomania
£640 sterling was paid for a bulb of a new tulip called the "City of Antwerp" – Ill. Lon. News 1842 Vol 1 461.

53 Aerial Navigation.
Description by Prof. Partington of Henslow's aerial carriage with sketches, & the reasons why it ought not to work. Ill. Lond. News. 1843 Vol 2. 234 244.

54 Velocipede
Locomotive machine was used between Brighton &

Statement Aug 31 1897

Edison Phonograph Works.

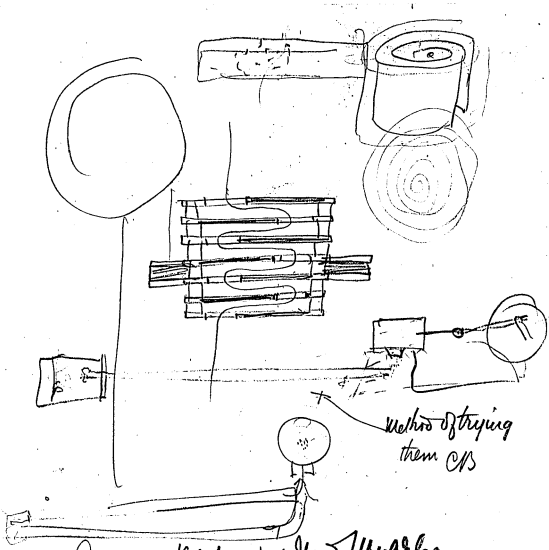
		Capital Stock	6	00.000	00
		Bonds	3	00.000	00
		Notes Payable		5500	00
		Accounts payable		7999	33
34974	58	Accounts Receivable: Good.			
418.869	87	Investments consisting of:- Mach. & tools, Real Est. & buildgs, Furniture & Fixt.			
40.000	00	Material (Raw & in process of Manuf.)			
318.100	00	Manufacturing Rights*. This Co owns the exclusive rights to manufacture phonographs and their accessories for the entire World except England & Germany. These were sold for $51.095.12, by this Co of which $31.319.50 was cash.			

Cost of Sales plus Gen'l Exp & Dep'n			Profits	Sales	
82.094	65	Year ending Feb. 29/96.	$23.139.97	107.234	62
114.189	73	" " " " 97.	$21.781.74	135.971	47
62.000	00	6 mos. Aug 31/97.	$13.862.77.	75.862	77
60.784	48.	To Profit			
319.068	86			319.068	86

The difference between the assets and liabilities represents losses incurred through failures of the Edn Phono. Toy. Mfg. Co & the Nth Amt Phono Co

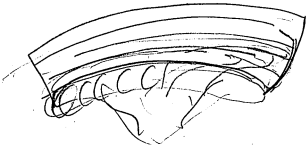
This Co has a Real Estate Mortgage with the Mutual Life Ins Co of N.Y. for $20,000, which, under the terms of the New Bond & Mortgage must be retired from surplus earnings above that necessary to pay interest on bonds.

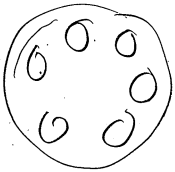
Copied Oct 28 1897 at Noyes office from Bevis's Copy.

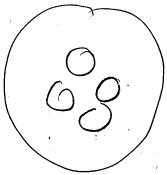


Edisons sketches for New Muggles
at Edison N.J. Oct 16th 1898
C/B

Edison Sketches for New Muzzles
Oct 16 1898
AB at Edison N.J.







Edisons Sketches for New Muzzles
Oct 16 1898
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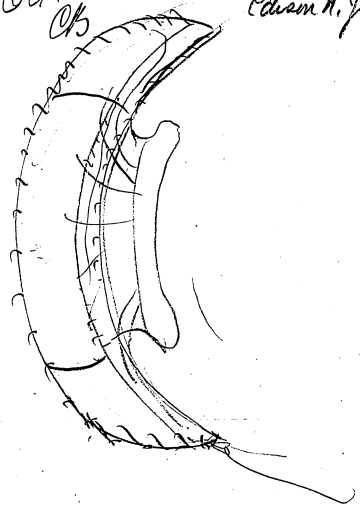
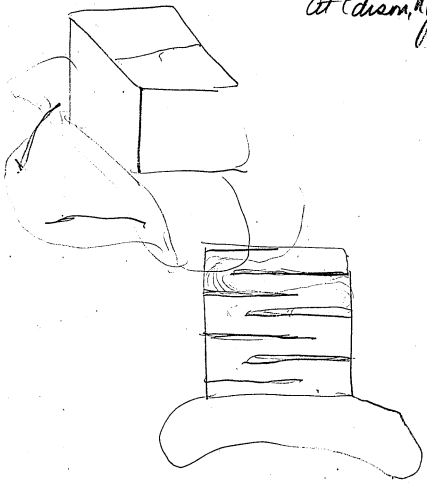
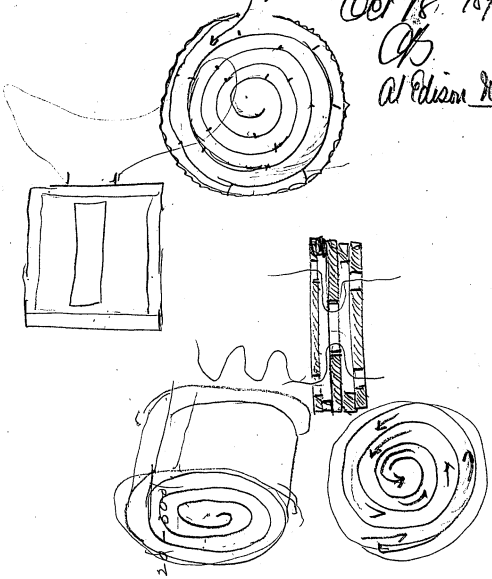
of
Edison N. J



Edison's Sketches for New Muzzles
OB
Oct 16 1898
At Edison, N.J.

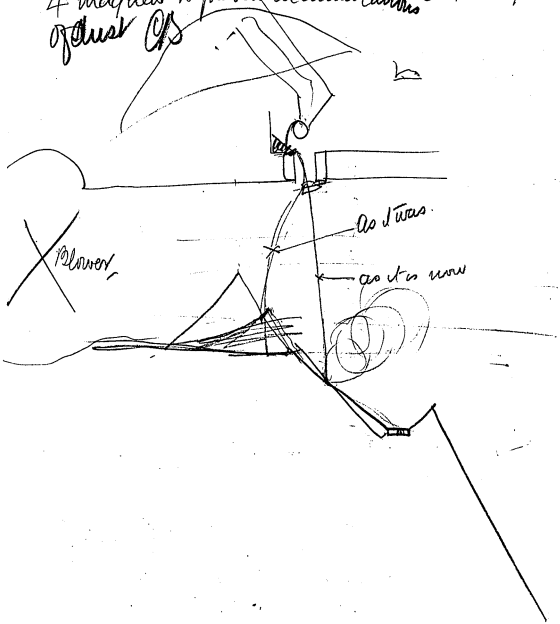


Edison's Sketches for New Muzzles
Oct 18th 1898
CB
at Edison N. J.

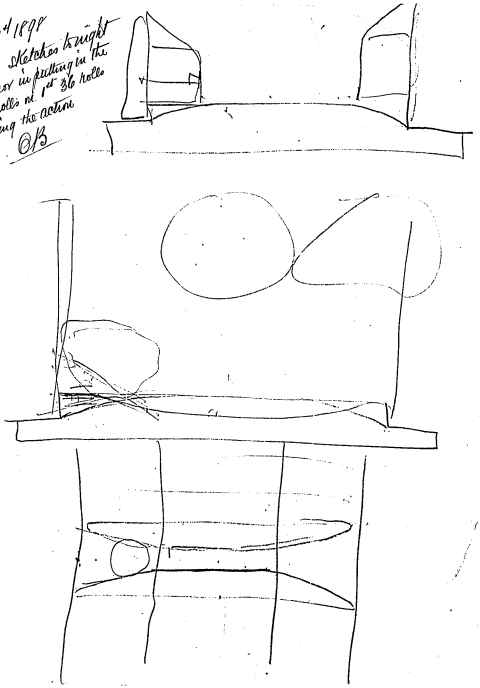


Edwin's Sketch of his alteration on 4" magnets to prevent accumulations of dust

Oct 18 1998



Dec 1st 1890
Edison sketches to night
of his error in putting in the
convex rolls at 1st 36 holes
+ explaining the action
O.B.



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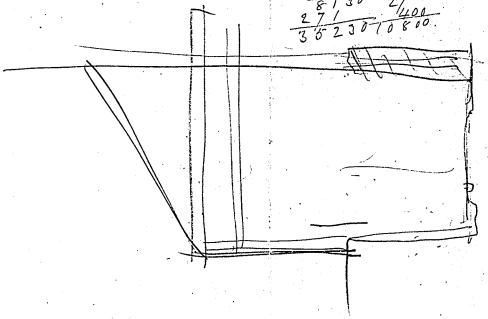

[ca. 1905] [INCOMPLETE]

Eclipse total of the Sun 1
July 29 1878

Mr Edison went with Prof Henry Draper – He went to Experiment with his Tasimeter an instrument he had invented to measure very small degrees of heat if possible & observe & measure the heat spectrum which observers then believed to exist in the extreme rays of the solar spectrum he believed at that time that he could measure to the 00000 part of a deg. Fah.

5000
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When he came back from this trip he told me of many projects to be worked up for future inventions amongst them one for harnessing the power of the falls for electricity & utilizing it in the mines for drills etc. He said he had talked a great deal with Prof Barker who was his companion in a journey to the Pacific Coast after they had observed the eclipse at Wankeye. Prof B had told him of some [illegible] he had seen at William Wallace's place at Ansonia Ct. & invited him to go up there & see them – They arranged a visit & I accompanied them. There we saw [illegible] Wallace's [illegible]

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3

as he called it at work lighting up six arc lights in series the lights appearing between two plates of carbon one above the other lengthwise with their long edges almost touching ~~We talked long that night on the value this machine would be in transmitting~~ He also generated a current with one machine & drove another with a large coil of wire between them to represent distance We talked long that night on the value this might be in transmitting power in the west & Edison arranged with Mr Wallace to send a machine to Menlo Park which he did about the middle of Sept of that Year 1878

4

Some months previous to this & before Edison went west on the Eclipse expedition I had assisted him in some experiments in which he was trying to raise to incandescence different substances in order to make an Electric Lamp We had no dynamo to produce current but we had a ~~large~~ lot of Bichromat of Potash battery of large capacity called Condit & Hanson Cells because we bought them from a firm of that name in Newark who manufactured Apparatus & Chemicals ~~made installations~~ for electroplating; with these we could make comparatively high or low volts with a correspondingly light or heavy currents - The result of these experiments was a very fine incandescence procured from very thin strips

of carbonized paper about 3/4" long 1/16" wide & the thickness of a visiting card before carbonizing say half a hundredth of an inch these were mounted in an instrument that we had in the Laboratory called a Gassiot's tube - It was a globe of glass that could be exhausted of air on the air pump & had a stop cock so that when the air was exhausted it could be removed from the pump - In the inside there was a short brass rod which rose from the centre about 1 inch with a small brass ball on the end & through the top there was another similar brass rod but longer when the first which could be raised & lowered so that the balls could be made to touch

or be set apart say 2 inches - On these two rods I fixed in place of the balls ~~fixed~~ small clamps to hold the different materials that we experimented with. We were very much astonished at the difference we noticed; when the pieces were illuminated in the bulb, when we had exhausted the air both as to the ease with which we got the light & the length of time they would last

All these experiments were in his mind when he went west & I have no doubt he gathered from Duff Barker & the other scientific men on that hip all that ~~was being done~~

51 al 170
25 al 103
20 al 37
294½ al 120
100 al 89
150 al 28
285 al 96
1 al 600
1000 al 28
200 al 11
248 44

~~He~~ had been done by other scientists in that line
Indeed he came home full of prospects for producing light in
large quantities ~~like gas~~ & distributing it in small units as is
done by gas — Early in September 1878 we were actively figuring out
stations that would deliver current to houses which could be used simply
for light, or for small power such as pumps, sewing machines,
printing presses & all sorts of manufacturing — All these could be turned
off & on at will without affecting any other — Mr Edison had had

---

Very little experience with dynamo machines
but he knew what other scientists such
as Forde & Siemens had done & of them
that in transforming energy they were more
economical than steam engines — He knew
that many installations were running in
which 1 machine ran 3, 5 or possibly 10
lights but these were large candle power
& unsuitable for domestic purposes & to re-
place gas — When he came back from
the West we spent many nights talking
over his ideas which were crude
about this: We can develop the electricity
in large quantities & lead it wherever we
want to use it by wires & then put in
lamps or motors which can be turned
on or off without affecting any other

of the supply – He illustrated it by pipes carrying water, ~~and~~ a supply tank above fed a main & small pipes with stopcocks all along the main led to the return pipe, which ran to another tank below – A pump constantly lifting the water from below to the top tank – When you turned a stopcock it let water through & represented a lamp or motor & the water found its way back to the top tank – When all were turned on it represented full current & pump working full capacity –

Before he went away he told me to make all Faraday's experiments on the single loop of wire cutting the field of force as he thought that that was the kind of

machine he should use. After he came back he had me make a machine of this kind giving me the rough figures & all the data he had figured out on the armature. The machine Mr Wallace sent to the laboratory which Edison had thought so much of whilst we saw it operating at Ansonia he soon found was not at all adapted to his use, for, as he said, it chewed up all its power itself whereas he wanted a machine that gave all its power to the outside circuit & retained the least possible for its own use. We had by this time got a small Gramme machine but this would not suit his ideas. He used to say no machine will do for me unless it can give 90% of its power outside of itself

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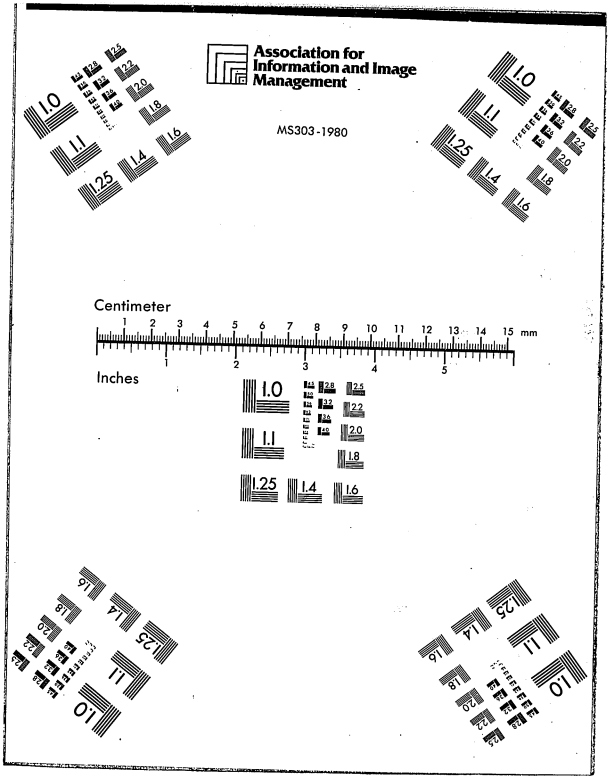
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